RMRA Alternatives Analysis Workshop Preliminary Results

- Ridership & Revenue
- Capital Costs
- Operating Costs
- Financial & Economic Results

April 24, 2009

High Speed Rail Feasibility Study



TEMS, Inc. / Quandel Consultants, LLC

Agenda

- **AFTERNOON**

1. Presentation of Alternatives Analysis Preliminary Results
 - Ridership and Revenue
 - Capital Costs
 - Operating Costs
2. Financial and Economic Analysis and Conclusions
3. Discussion of Results and Input to Inform Short-listing of Alternatives
4. Public Comment and Input

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Alternatives Analysis Preliminary Results

- Using the Methodologies that were presented to the Peer Panel, the following assessments have been completed
- Ridership and revenue
- Capital cost summary
- Operations
- Financial and economic analysis

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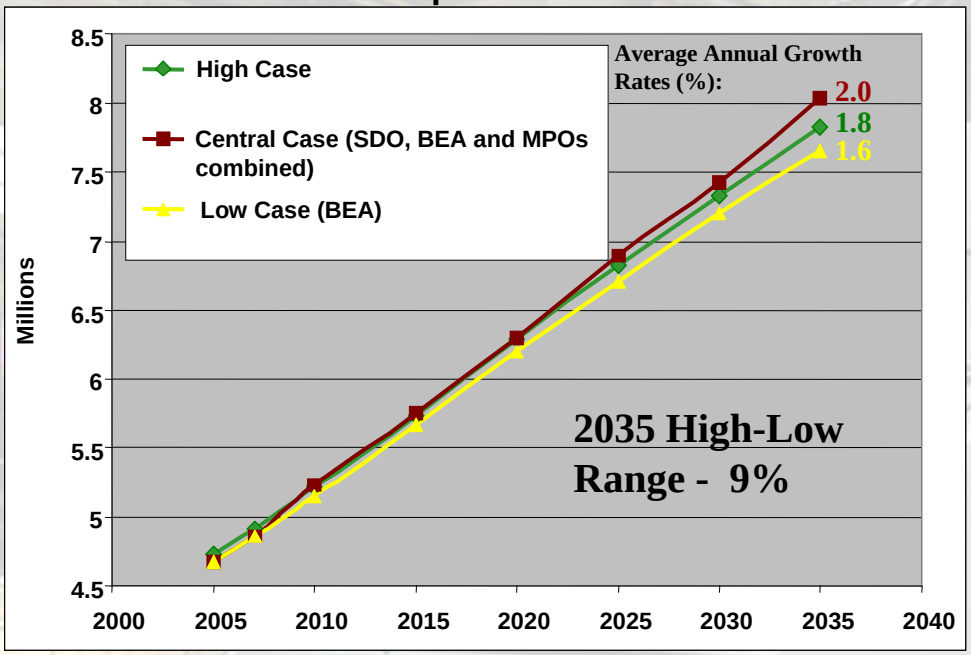


Ridership & Revenue Assumptions

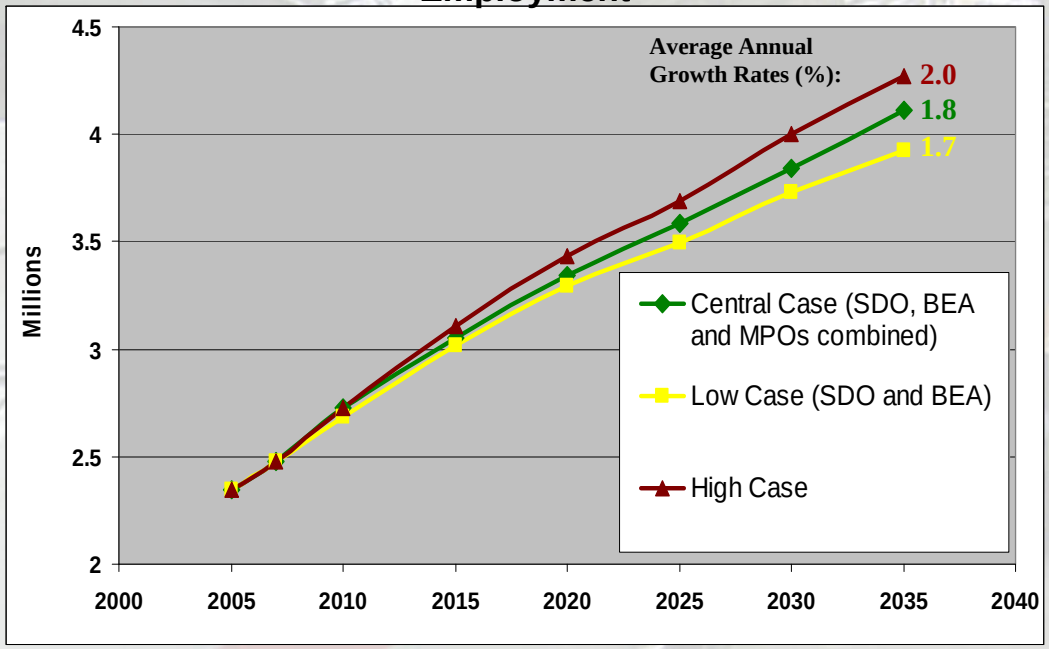
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Colorado Economic Scenarios

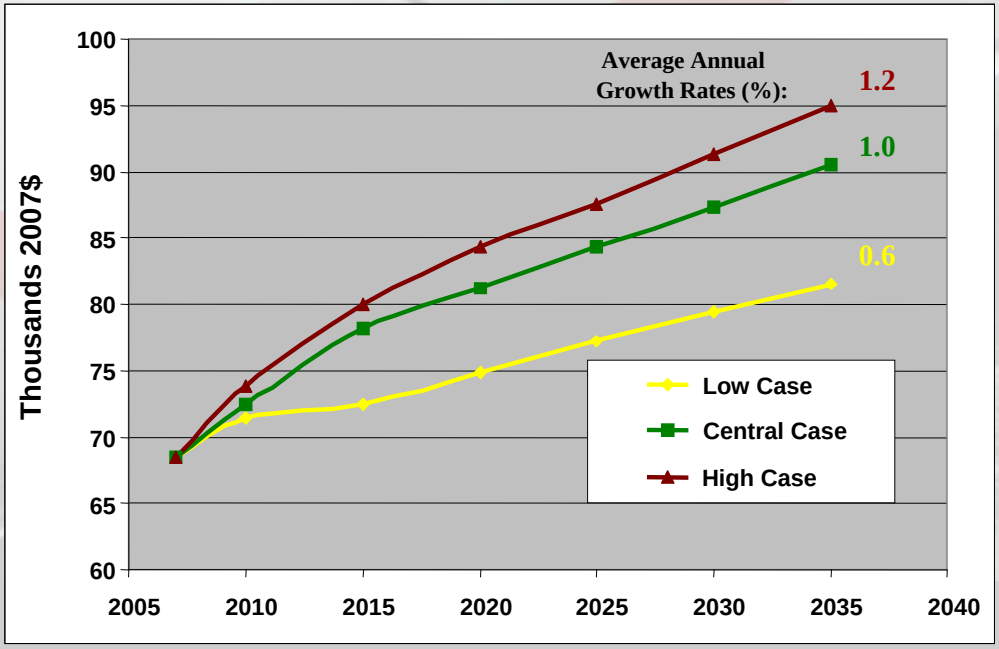
Population



Employment



Income

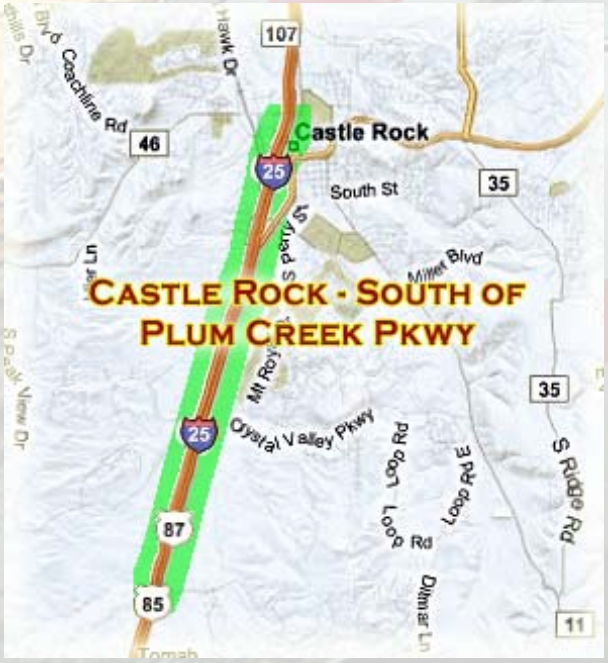


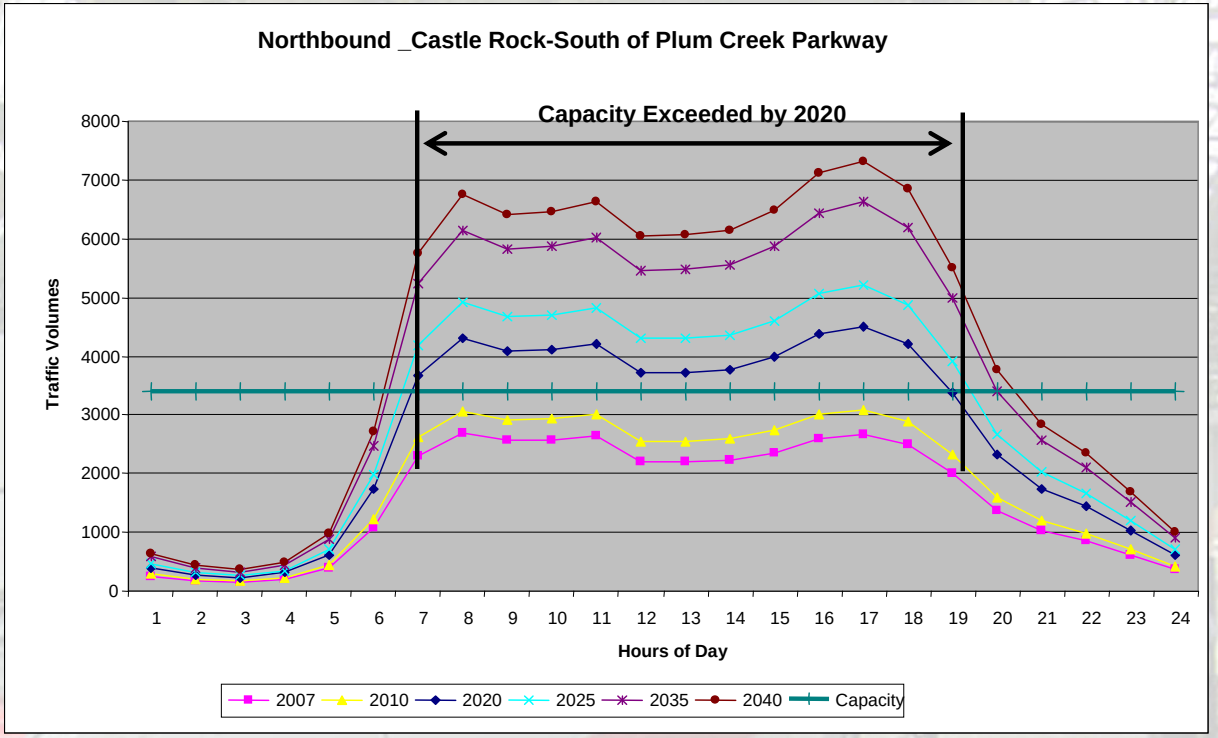
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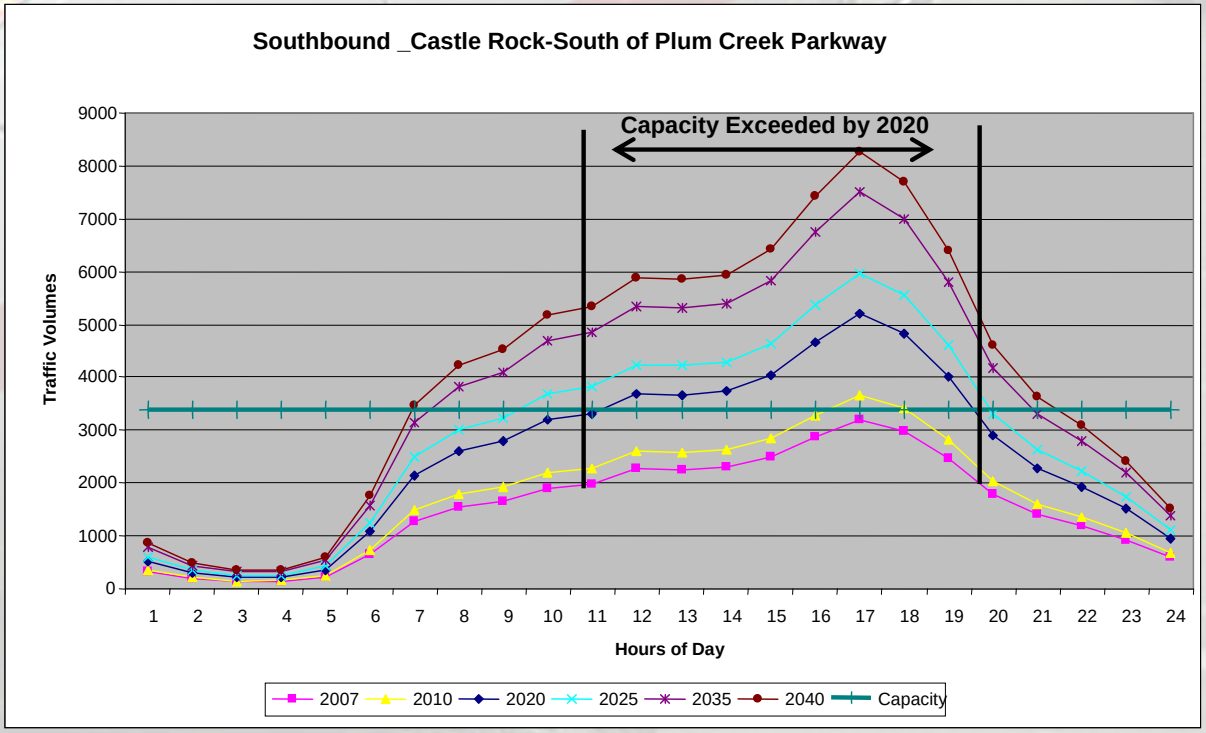
I-25 Hourly Traffic Volumes:

Castle Rock-South of Plum Creek Parkway:

Typical Day

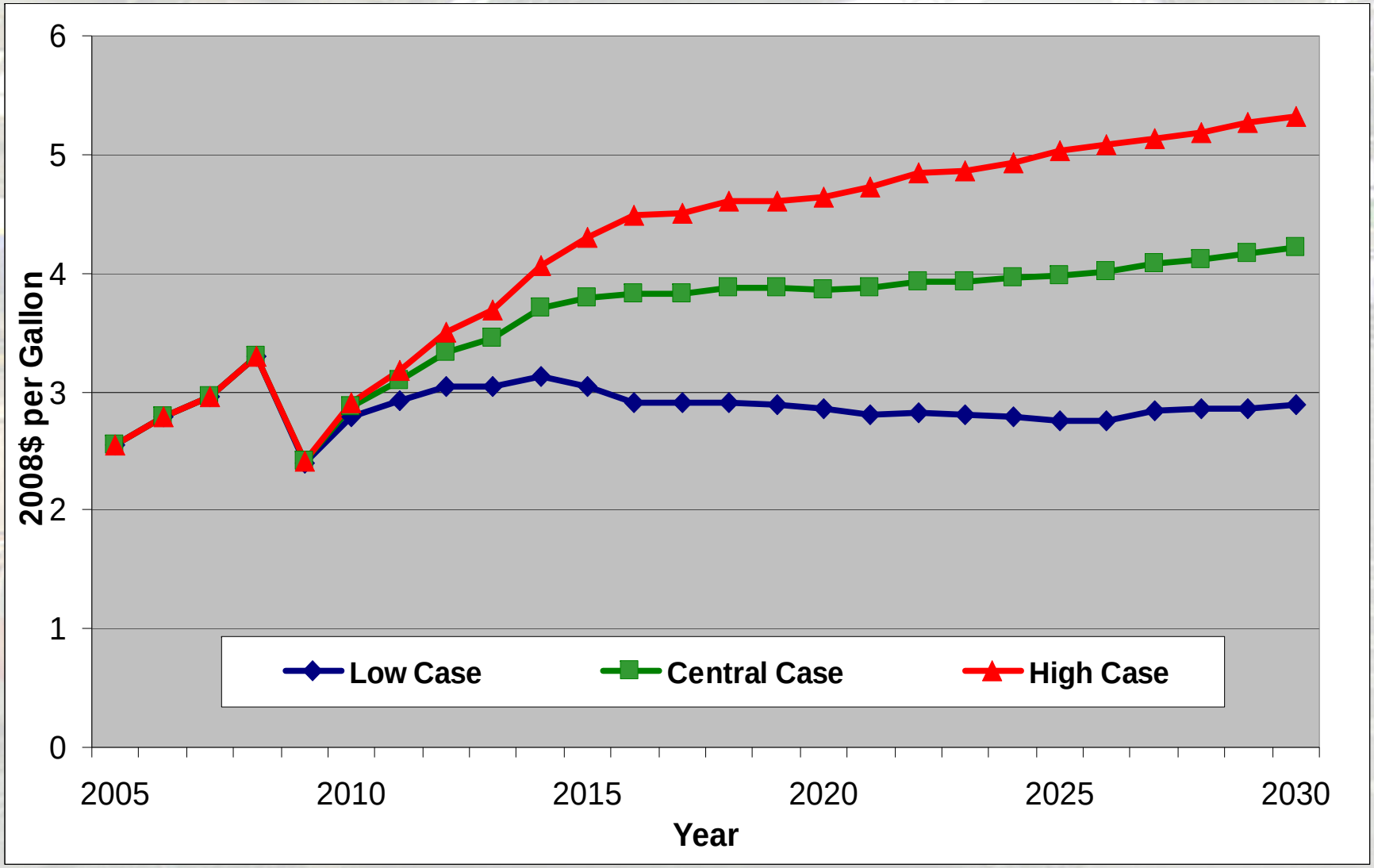






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U.S. Retail Gasoline Prices - Historic Data and the Forecasts



Source: TEMS, Inc and Energy Information Administration.

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Frequencies and Fares

Higher Speed technologies can typically support higher fares and frequencies. This optimizes the potential for each particular technology.

Trains / day	Fare / Mi	4	6	8	10	12	14	16	18	20	24	30
79 mph	20¢	X	X	X								
110 mph	28¢			X	X	X						
125 mph	30¢			X	X	X						
150 mph	32¢					X	X	X				
220 mph	38¢						X	X	X	X		
300 mph	45¢							X	X	X	X	X

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Two Network Options to be Evaluated

#1 – I-70 Unconstrained (4%) with Existing Rail I-25

Conventional Amtrak

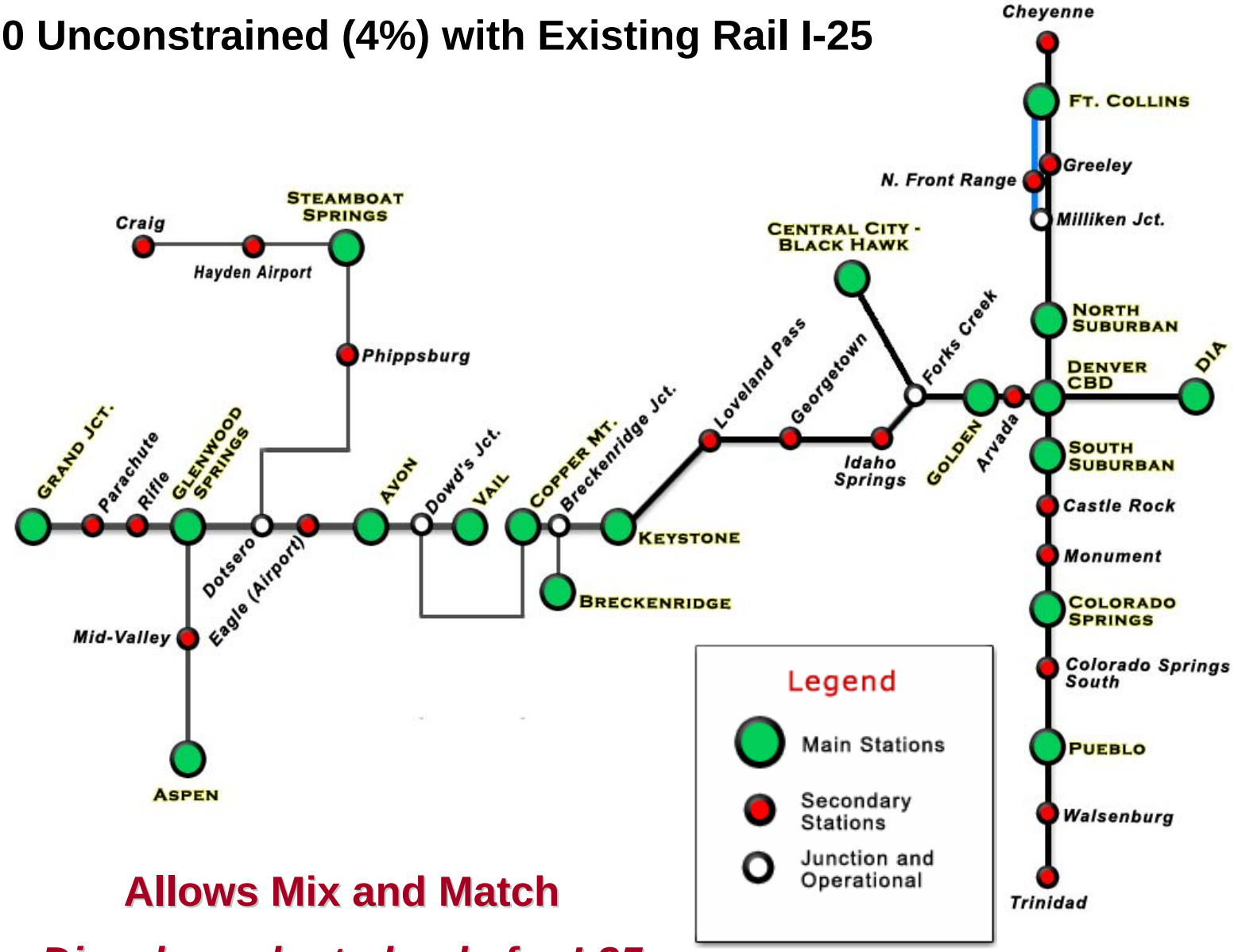


Talgo T21



Eurostar





Allows Mix and Match

Diesels evaluated only for I-25

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Two Network Options to be Evaluated

#2 – I-70 ROW (7%) with Greenfield I-25

Proposed Colorado Maglev

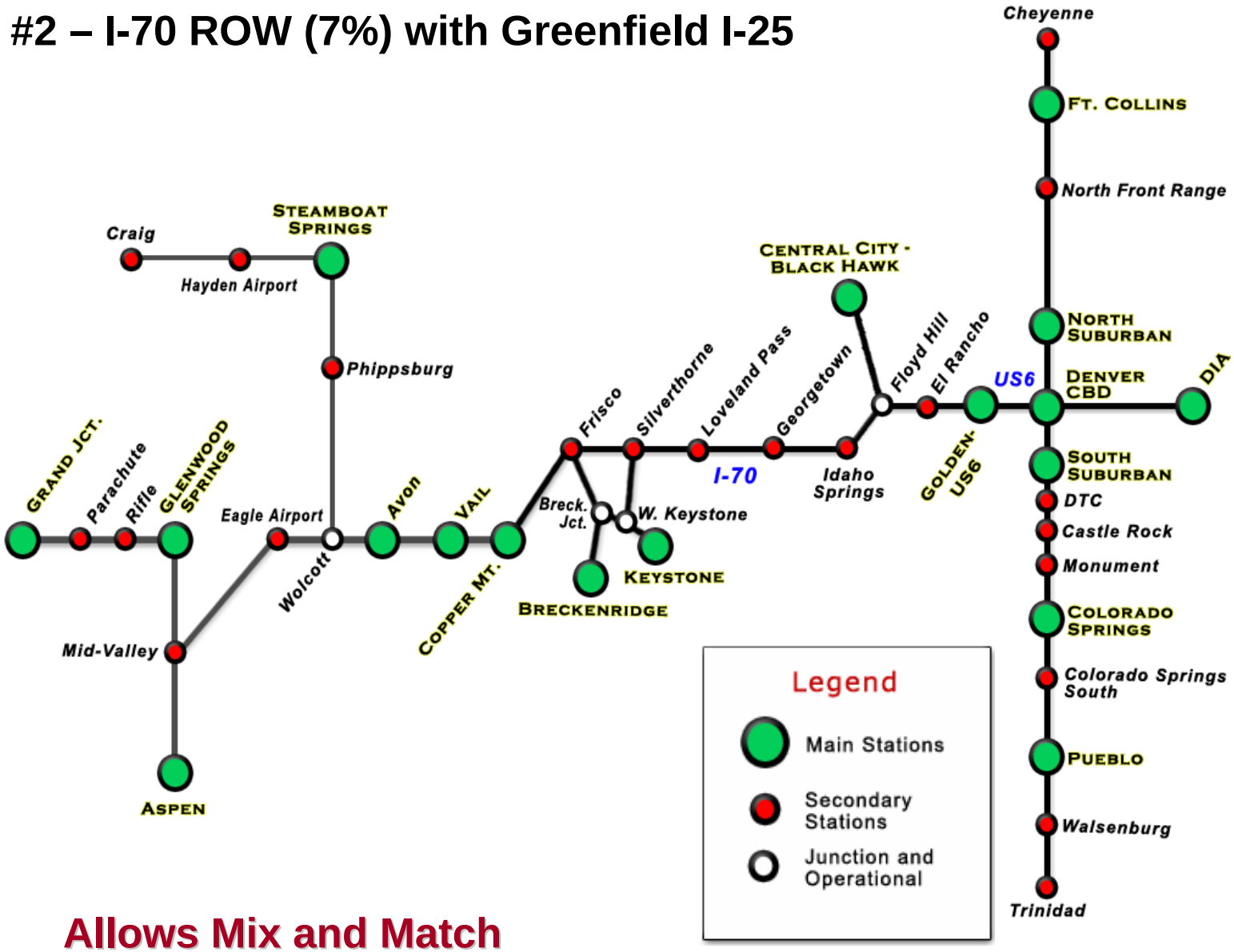


ICE EMU



Transrapid Maglev





Allows Mix and Match

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Ridership & Revenue

Central Demographics / Low Gas Case

Results and Sensitivities

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Ridership for Technologies (millions of riders)

(Central Demographic/Low Gas Case by Alternative Technology and Year)

	2015	2025	2035	2045
79 mph (ER)	0.98	1.37	1.83	2.39
110 mph (ER)	3.68	4.95	6.56	8.51
125 mph (RW/GF)	12.97	17.23	22.90	29.73
150 mph (UC/ER)	11.67	15.53	20.64	26.79
220 mph (RW/GF)	15.64	20.69	27.43	35.52
300 mph (RW/GF)	17.88	23.65	31.35	40.60

Key

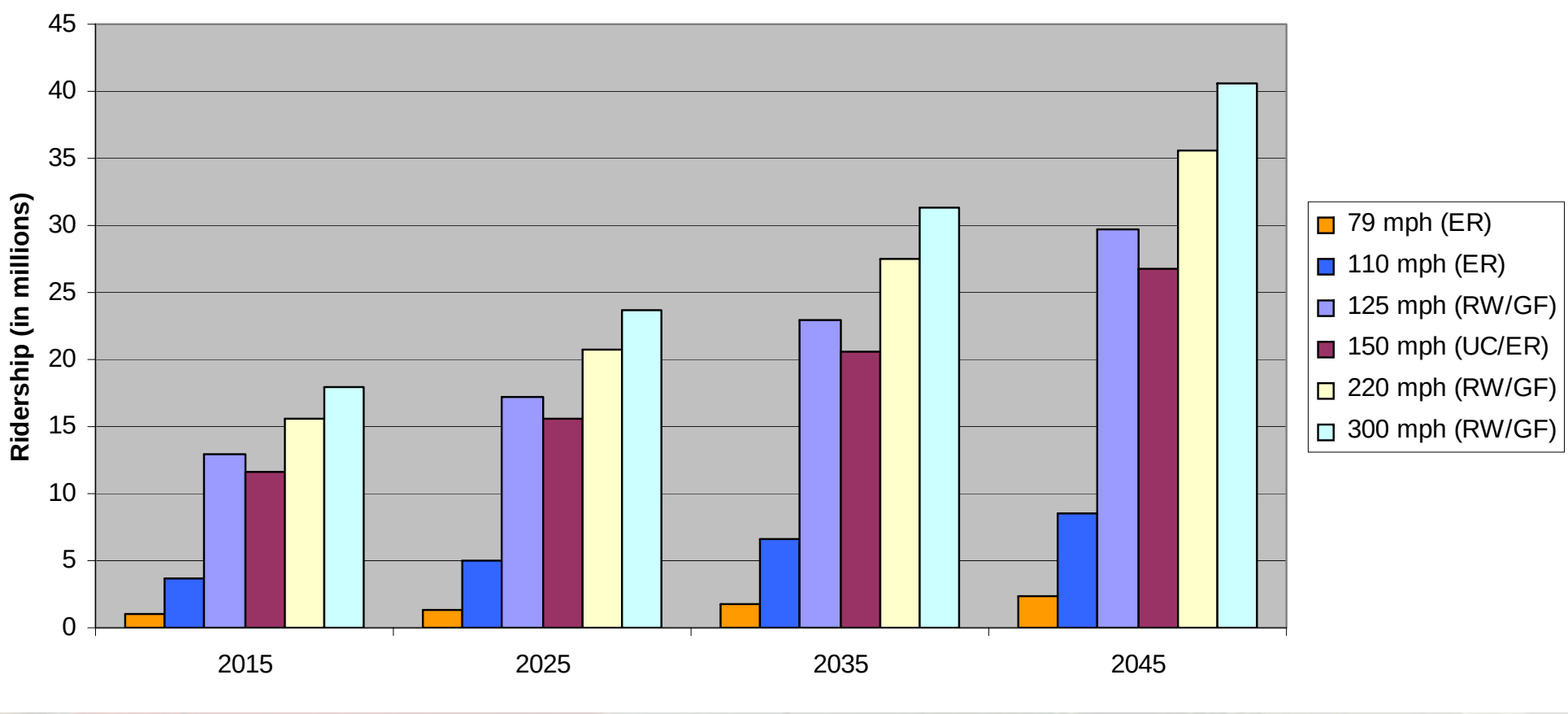
ER: I-25 Existing Rail
GF: I-25 Greenfield
RW: I-70 Right of Way 7%
UC: I-70 Unconstrained 4%

Higher Speed Technologies result in substantially Higher Ridership. Traffic also grows as a result of higher Demographics in later years.

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Ridership by year (millions of riders)

(Central Demographic/Low Gas Case by Alternative Technology and Year)



Key

ER: I-25 Existing Rail
GF: I-25 Greenfield
RW: I-70 Right of Way 7%
UC: I-70 Unconstrained 4%

150-mph Ridership is lower because it uses the Existing Rail alignments on I-25 and west of Eagle; other High Speed technologies use Greenfield alignments, which although more expensive, are faster and have better station locations.

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Revenue for Technologies ($ millions)

(Central Demographic/Low Gas)

	2015	2025	2035	2045
79 mph (ER)	11.61	16.19	19.62	24.36
110 mph (ER)	56.63	78.25	103.97	135.66
125 mph (RW/GF)	300.07	405.53	521.24	654.28
150 mph (UC/ER)	279.16	377.44	485.04	608.50
220 mph (RW/GF)	392.76	529.37	679.28	851.22
300 mph (RW/GF)	485.55	654.92	878.18	1156.13

Key

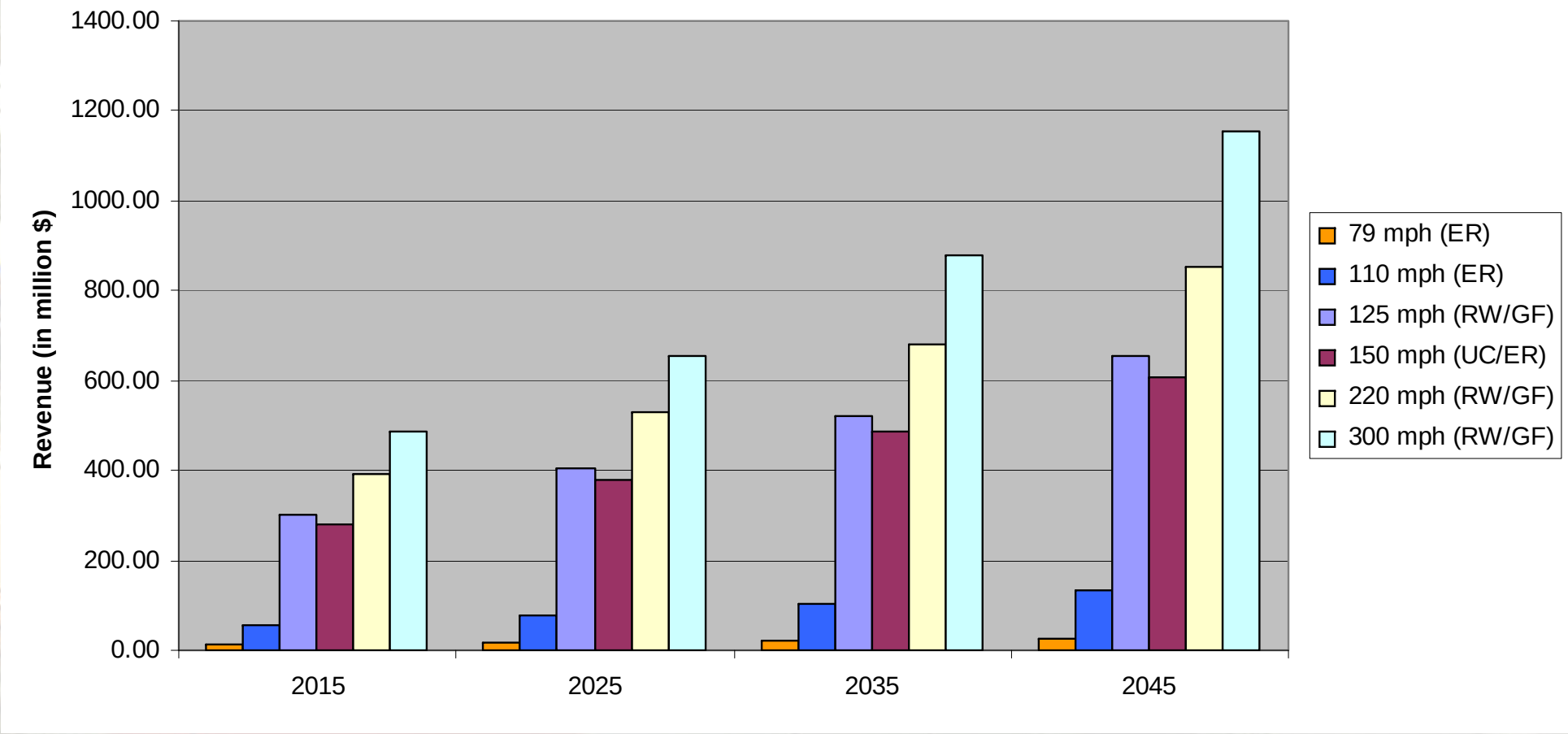
ER: I-25 Existing Rail
GF: I-25 Greenfield
RW: I-70 Right of Way 7%
UC: I-70 Unconstrained 4%

Note disproportionate increase in Revenue compared to Ridership of Higher Speed technologies, because of the ability to support higher fares.

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Revenue by year ($ millions)

(Central Demographic/Low Gas Case by Alternative Technology and Year)



Key

ER: I-25 Existing Rail
GF: I-25 Greenfield
RW: I-70 Right of Way 7%
UC: I-70 Unconstrained 4%

Again, the dip in revenue for 150-mph technology is due to use of Existing Rail on I-25 and west of Eagle. This masks the effect of a potentially better alignment from Denver to Eagle, which will be assessed in the Business Planning phase.

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Ridership Components

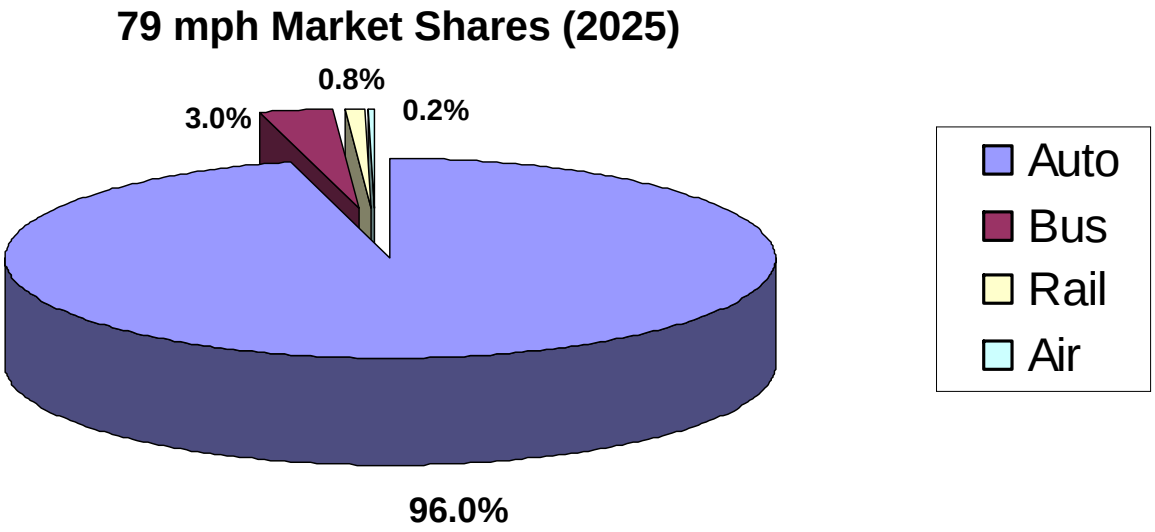
- Base Demand – Demand in base year
- Natural Growth – Socioeconomic Impact
- Induced Demand – Improved accessibility
- Diverted – Attracted from other modes

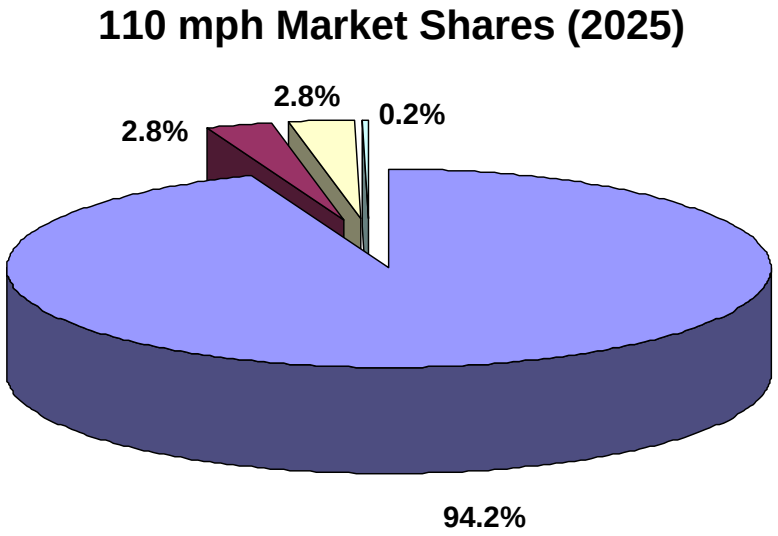
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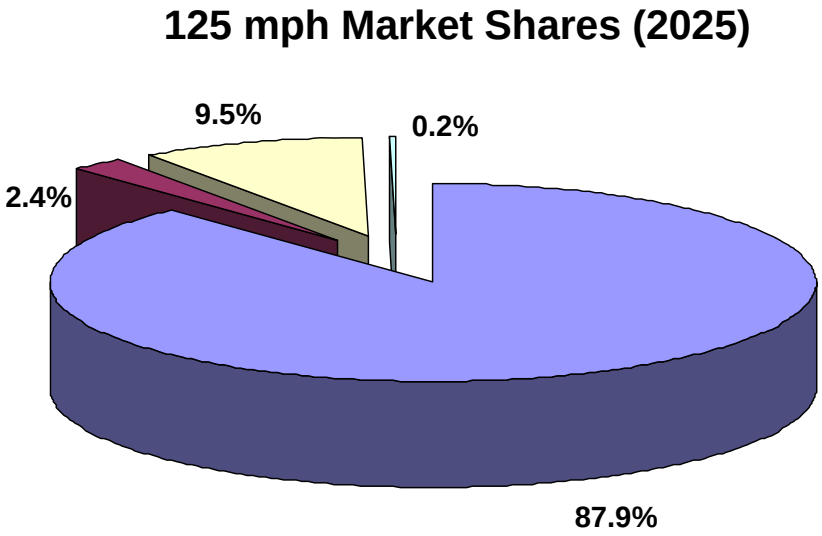
Market Shares

(Central Demographic/Low Gas, 2025; for 79, 110, 125-mph)

214 Million Total Trips



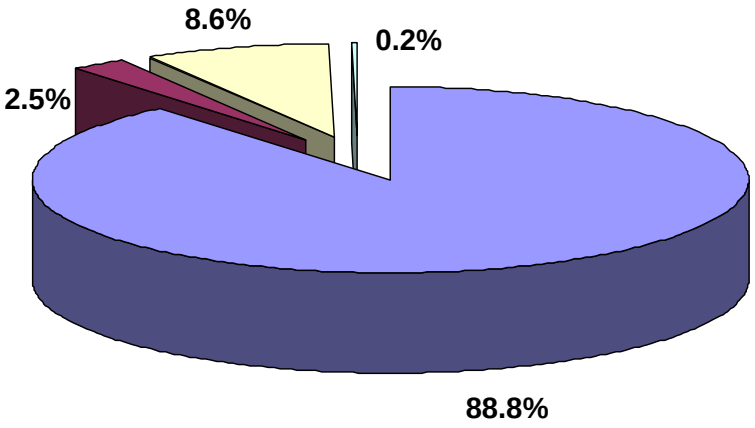




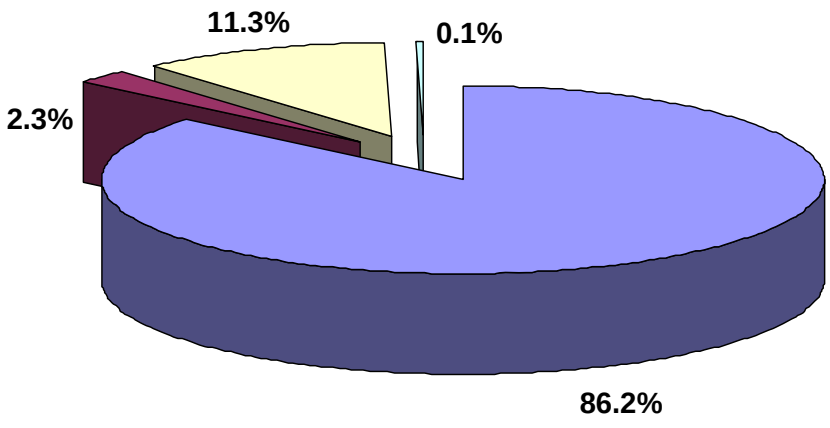
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Market Shares
(Central Demographic/Low Gas, 2025; for 150, 220, 300-mph)

150 mph Market Shares (2025)

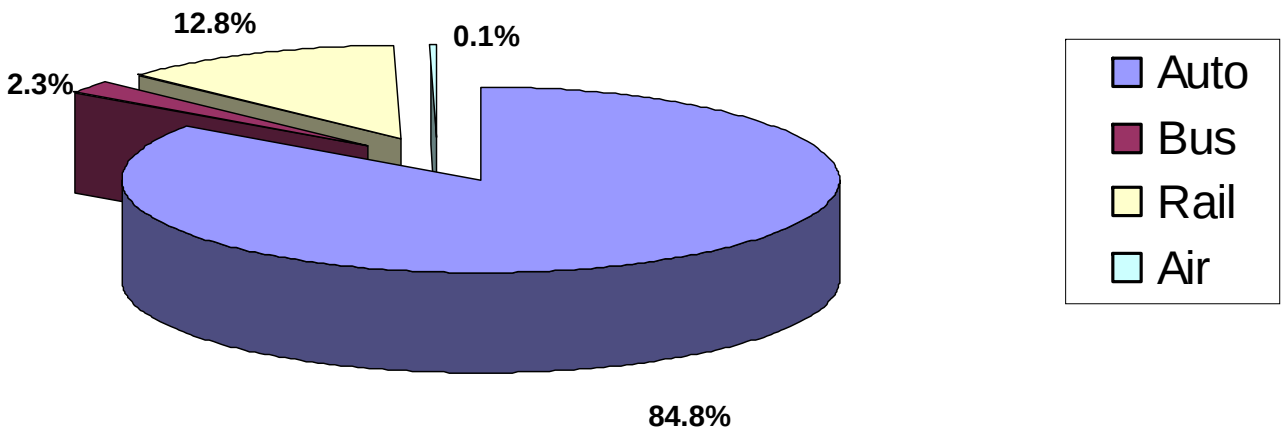


220 mph Market Shares (2025)



214 Million Total Trips

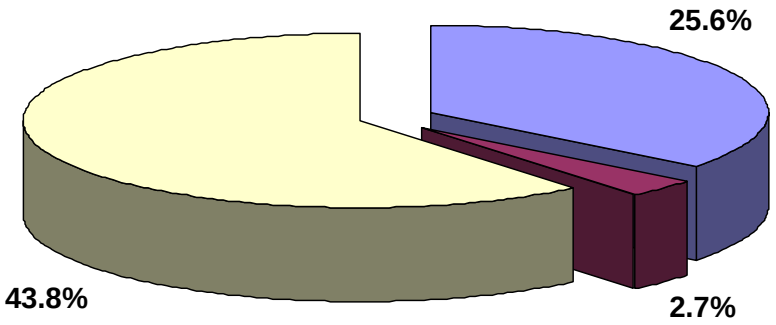
300 mph Market Shares (2025)



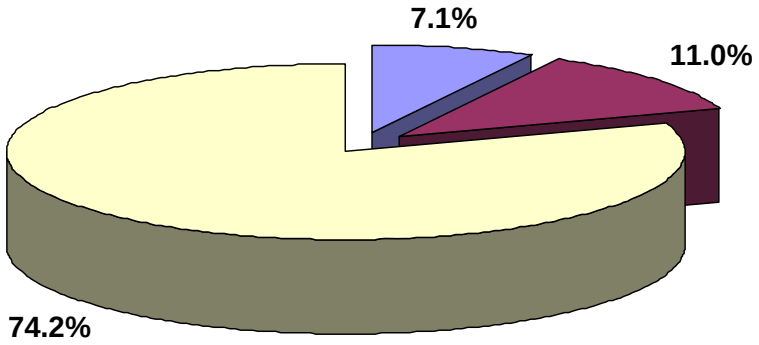
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Source of Rail Ridership
(Central Demographic/Low Gas, 2025; for 79,110,125-mph)

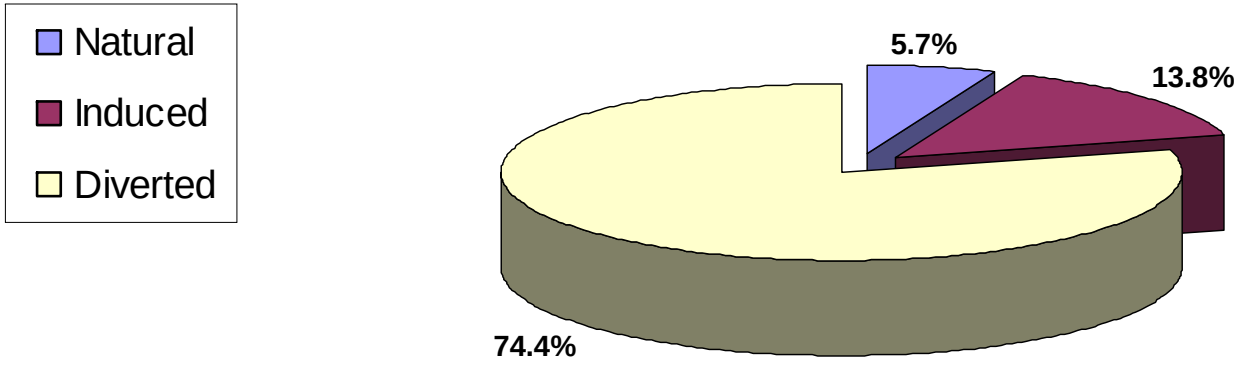
Demand Shares – 79 mph



Demand Shares – 110 mph



Demand Shares – 125 mph

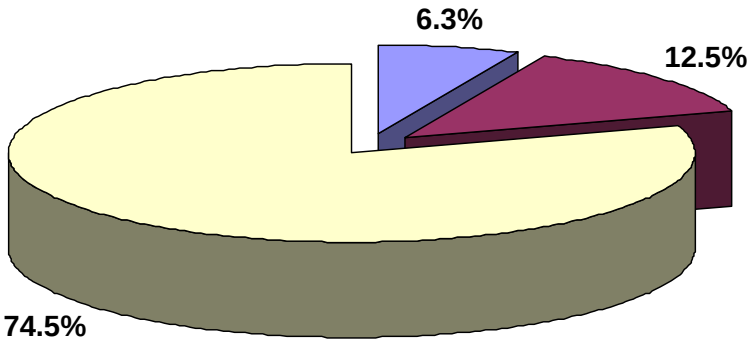


214 Million Total Trips

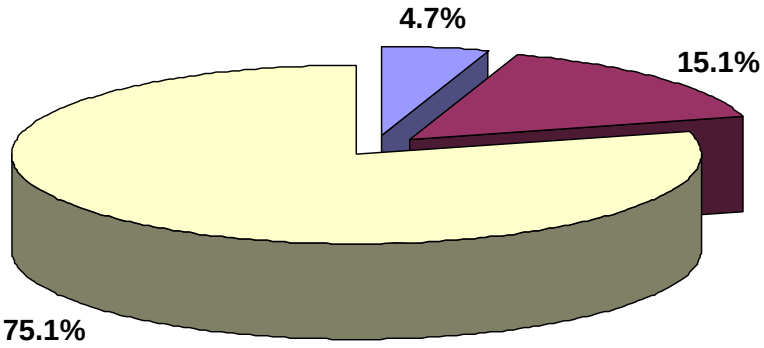
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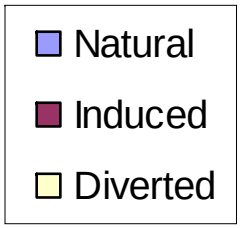
Source of Ridership
(Central Demographic/Low Gas, 2025; for 150, 220, 300-mph)

Demand Shares – 150 mph

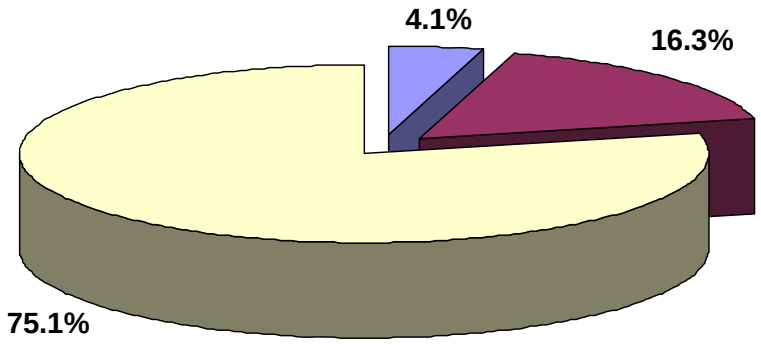


Demand Shares – 220 mph





Demand Shares – 300 mph



214 Million Total Trips

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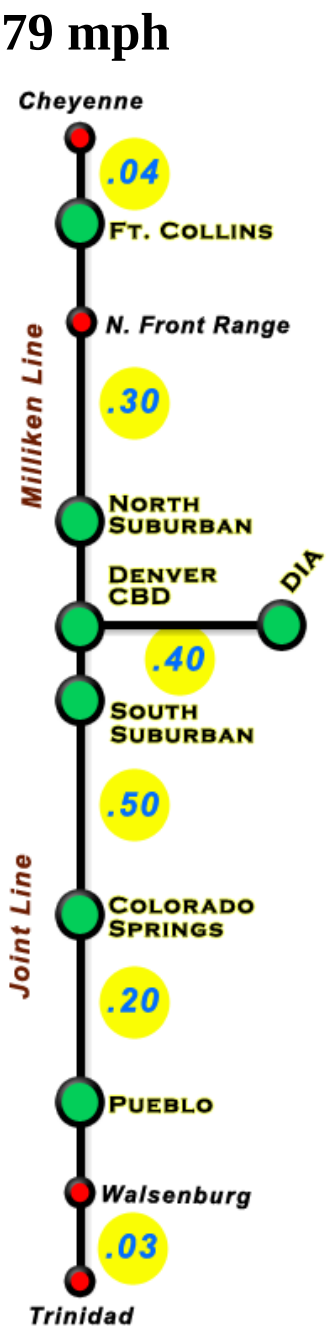
Ridership: Millions of Riders –

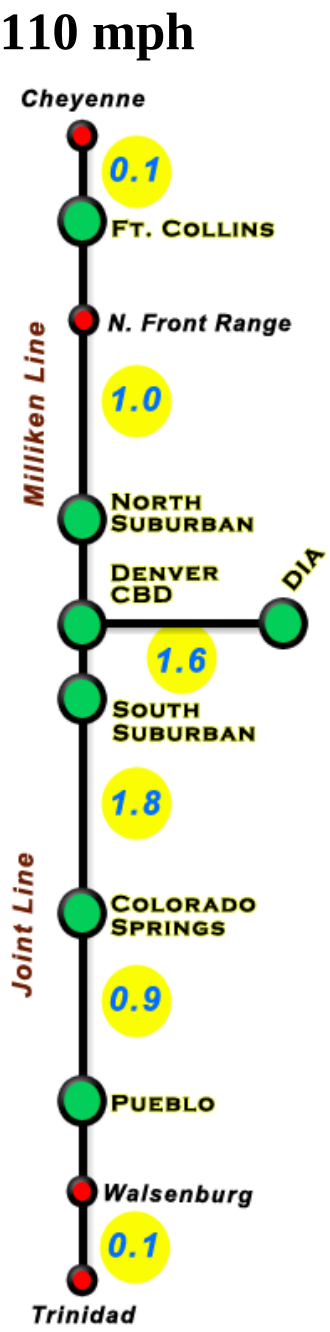
(Central Demographic/ Low Gas, 2025)

79-mph:
1.37 Million per year

110-mph:
4.95 Million per year

I-25 – Existing Rail



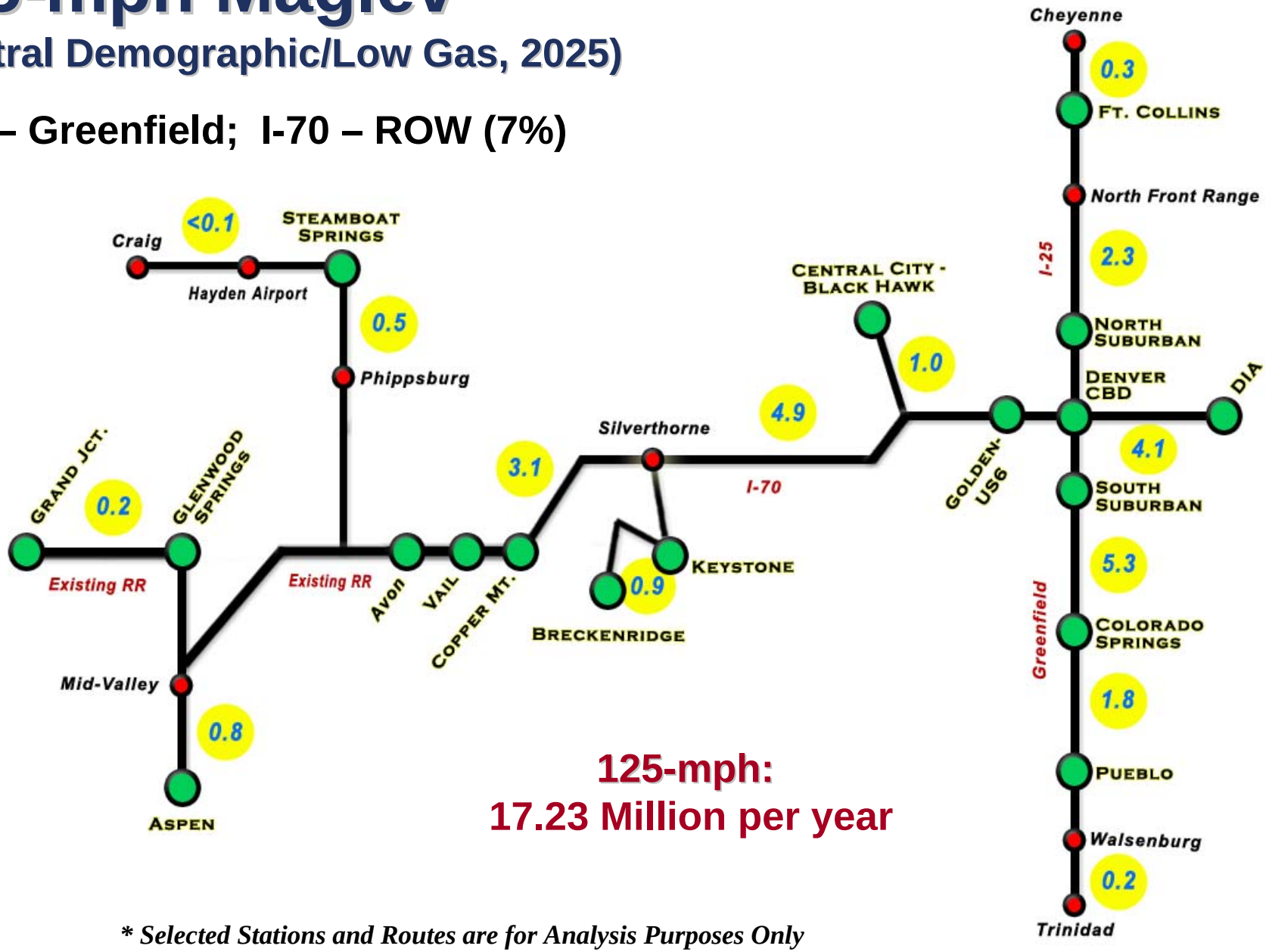


** Selected Stations and Routes are for Analysis Purposes Only*

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Ridership: Millions of Riders
125-mph Maglev
(Central Demographic/Low Gas, 2025)

I-25 – Greenfield; I-70 – ROW (7%)



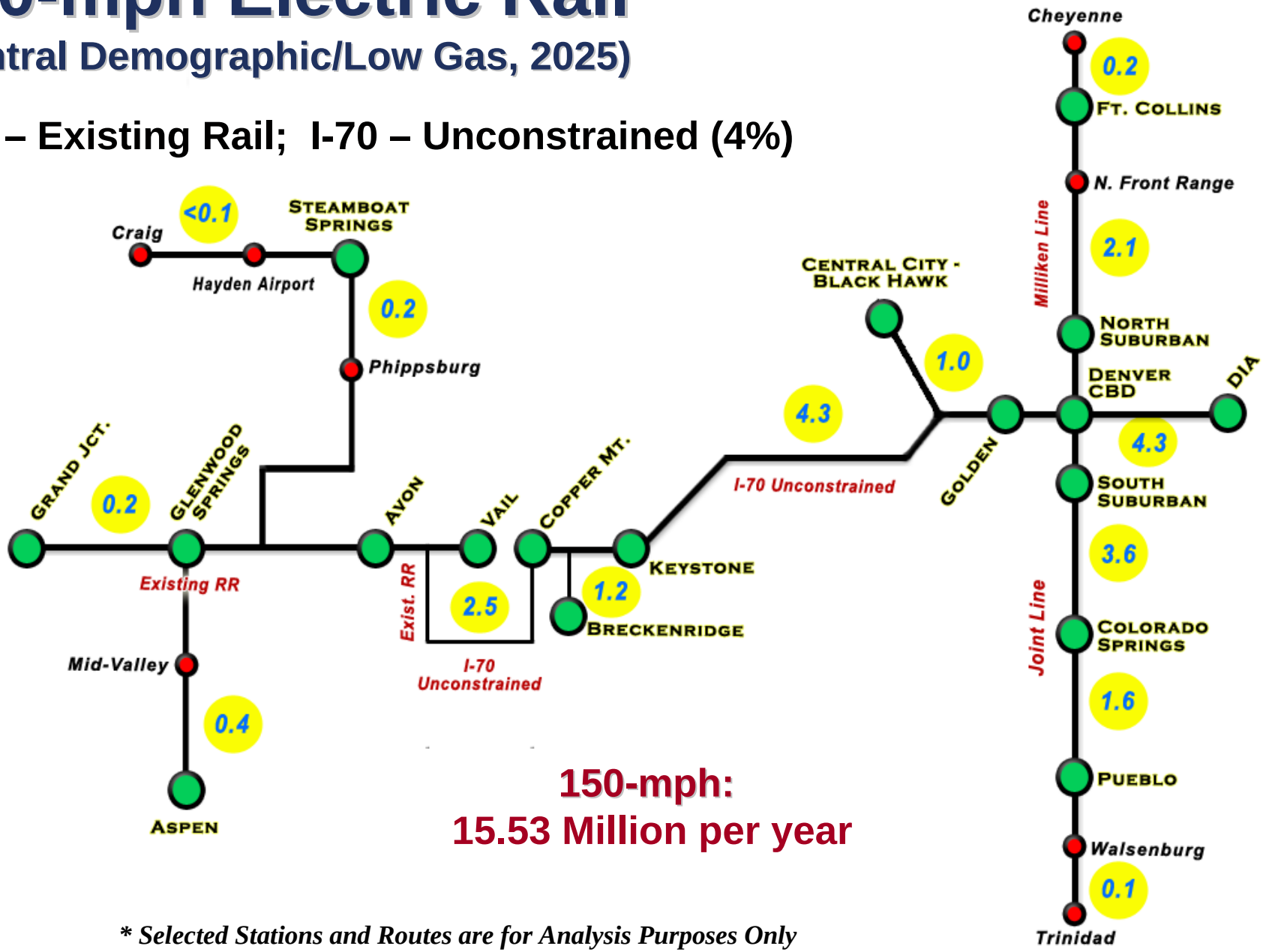
125-mph:
17.23 Million per year

** Selected Stations and Routes are for Analysis Purposes Only*

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Ridership: Millions of Riders
150-mph Electric Rail
(Central Demographic/Low Gas, 2025)

I-25 – Existing Rail; I-70 – Unconstrained (4%)



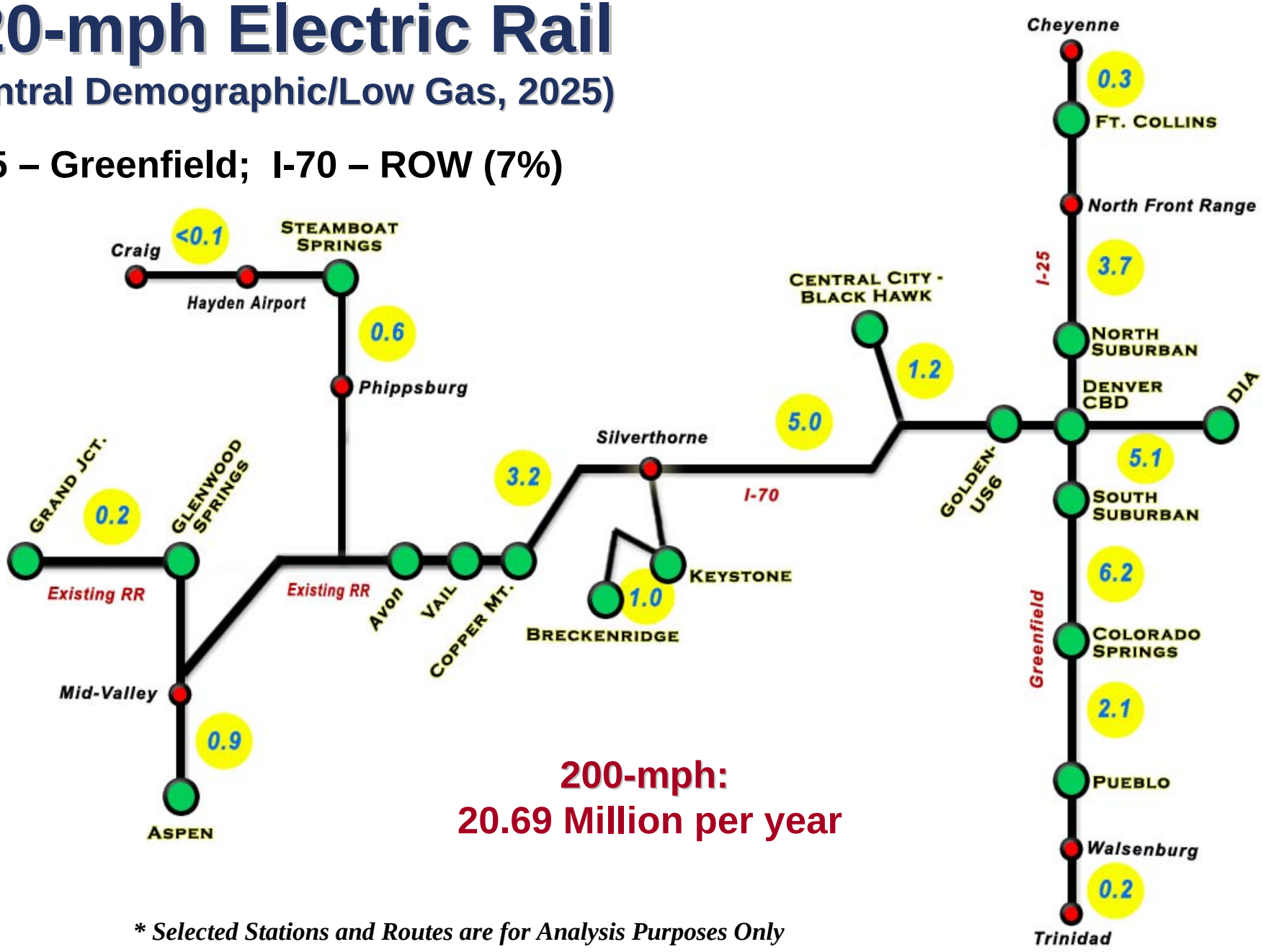
150-mph:
15.53 Million per year

** Selected Stations and Routes are for Analysis Purposes Only*

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Ridership: Millions of Riders
220-mph Electric Rail
(Central Demographic/Low Gas, 2025)

I-25 – Greenfield; I-70 – ROW (7%)



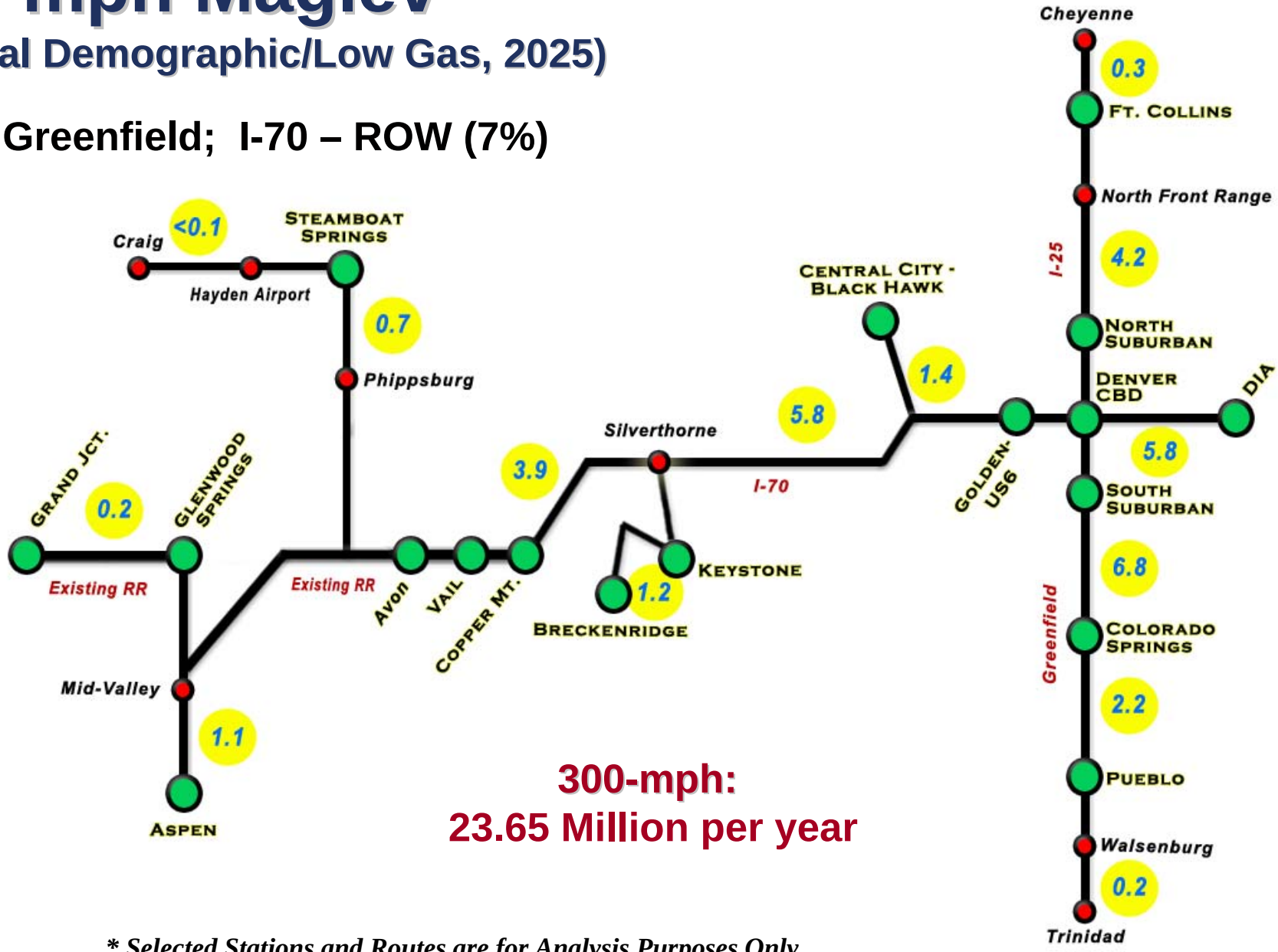
200-mph:
20.69 Million per year

** Selected Stations and Routes are for Analysis Purposes Only*

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Ridership: Millions of Riders
300-mph Maglev
(Central Demographic/Low Gas, 2025)

I-25 – Greenfield; I-70 – ROW (7%)

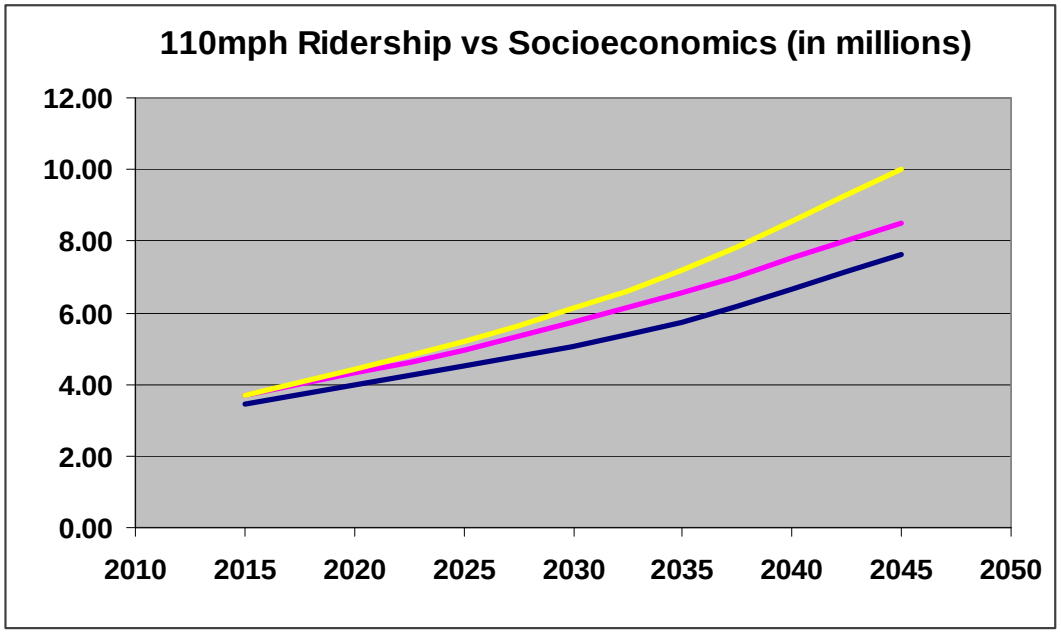


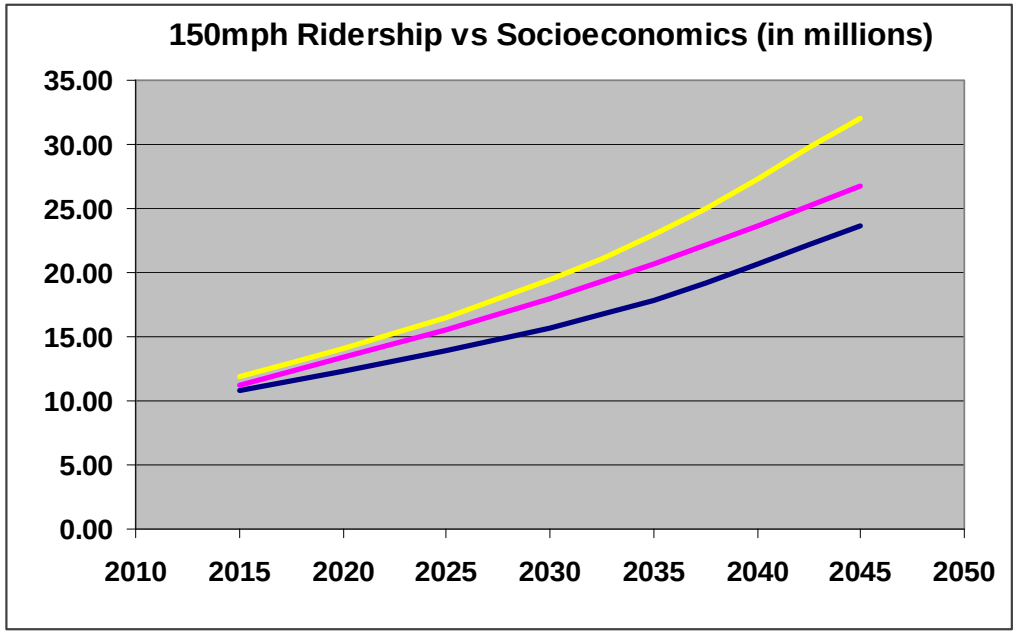
300-mph:
23.65 Million per year

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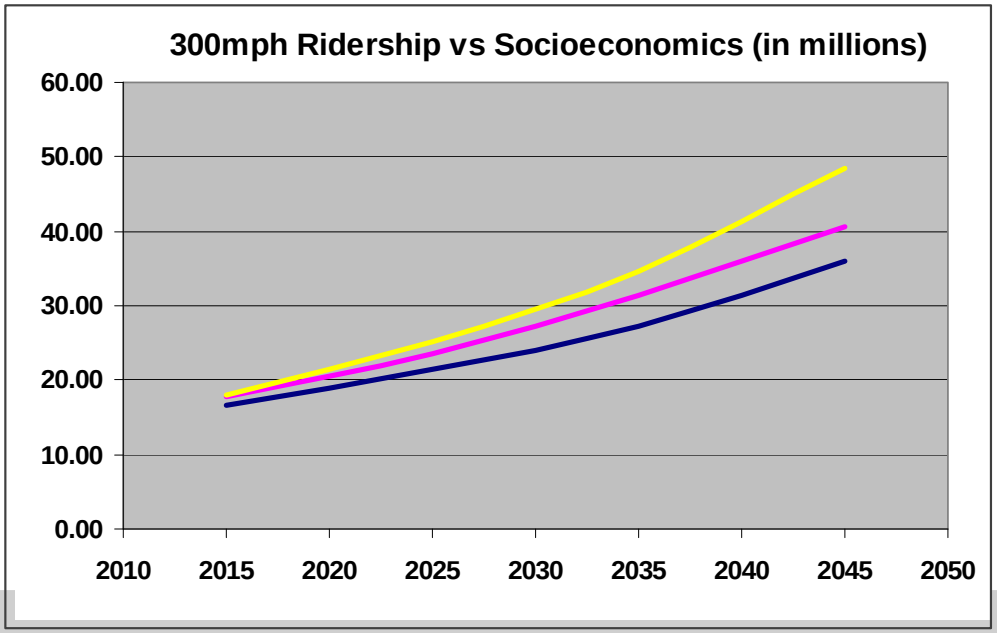
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Ridership Sensitivity
Impact of Socioeconomic Scenarios



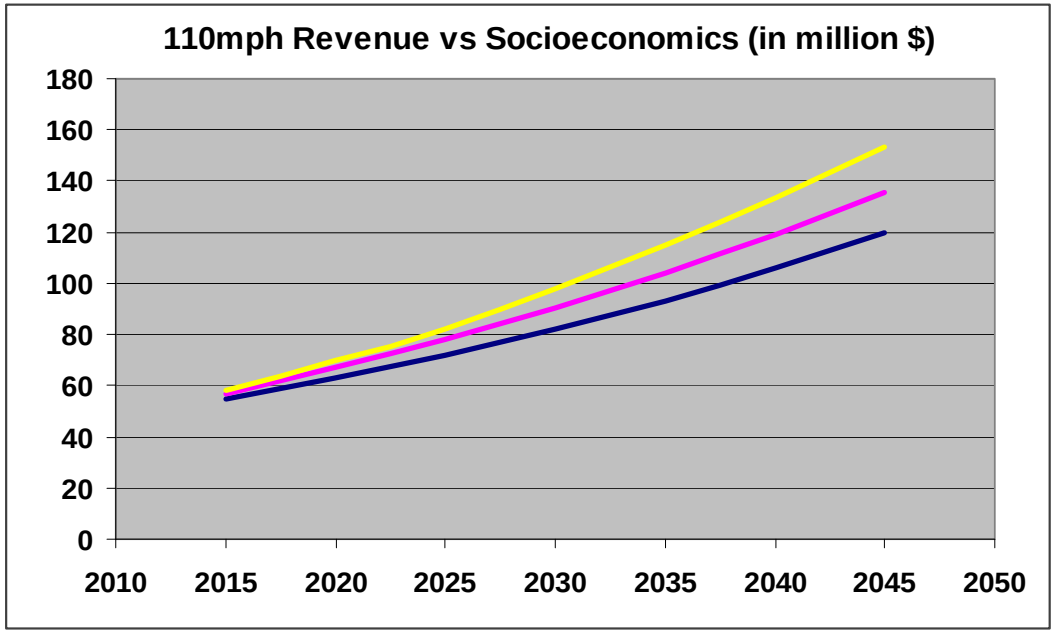


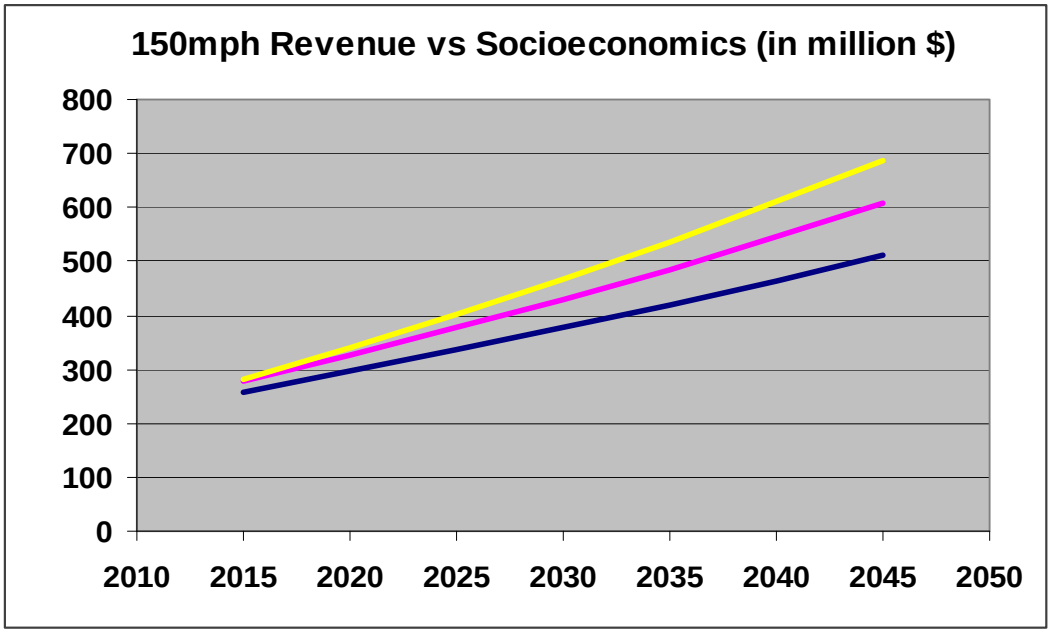
Central Demographic/ Low Gas



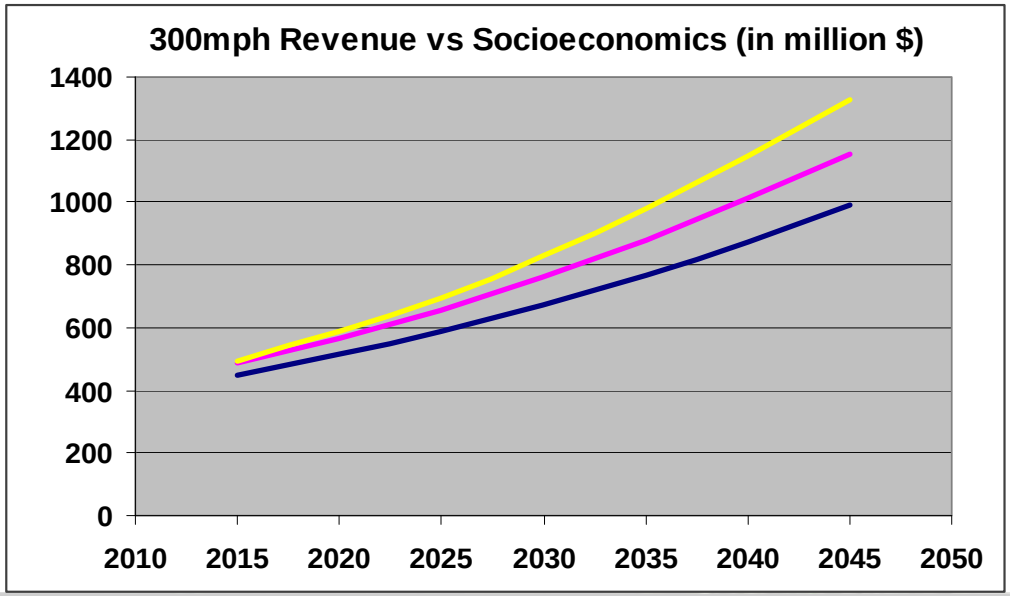
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Revenue Sensitivity
Impact of Socioeconomic Scenarios



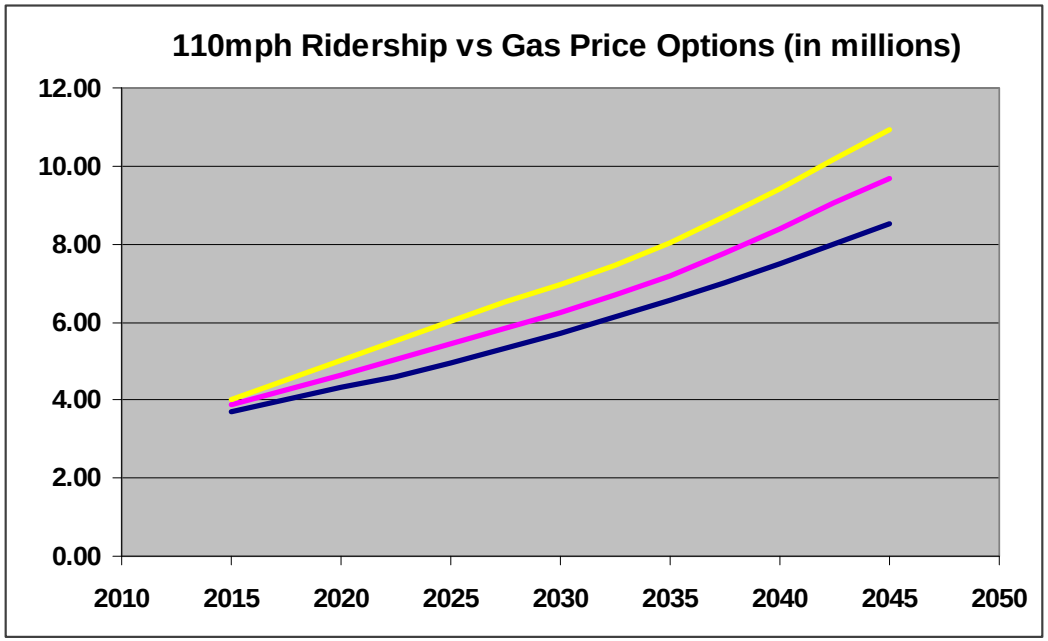


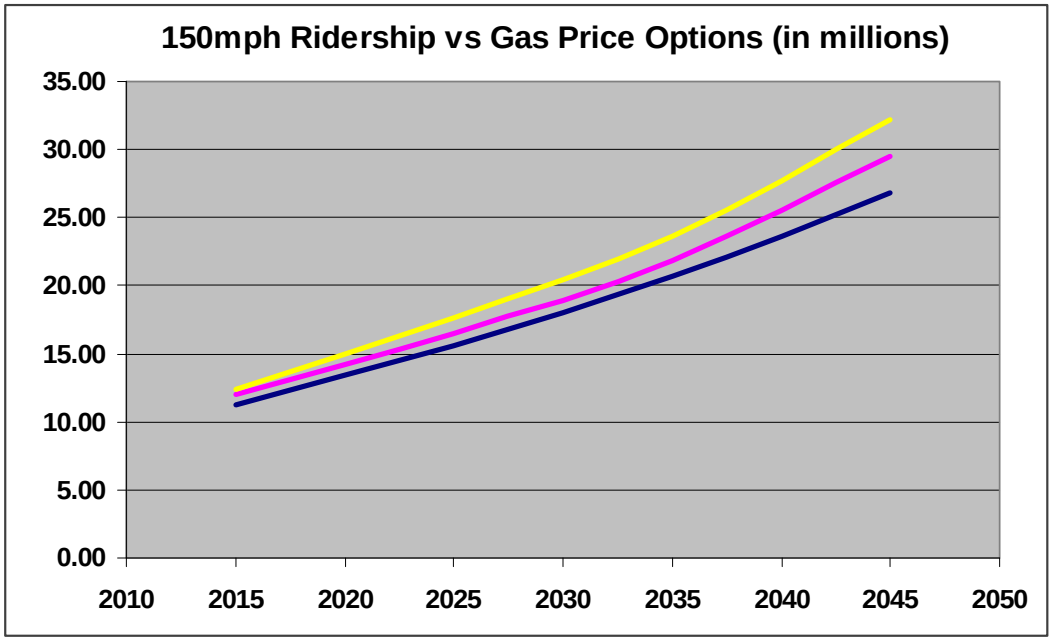
Central Demographic/ Low Gas



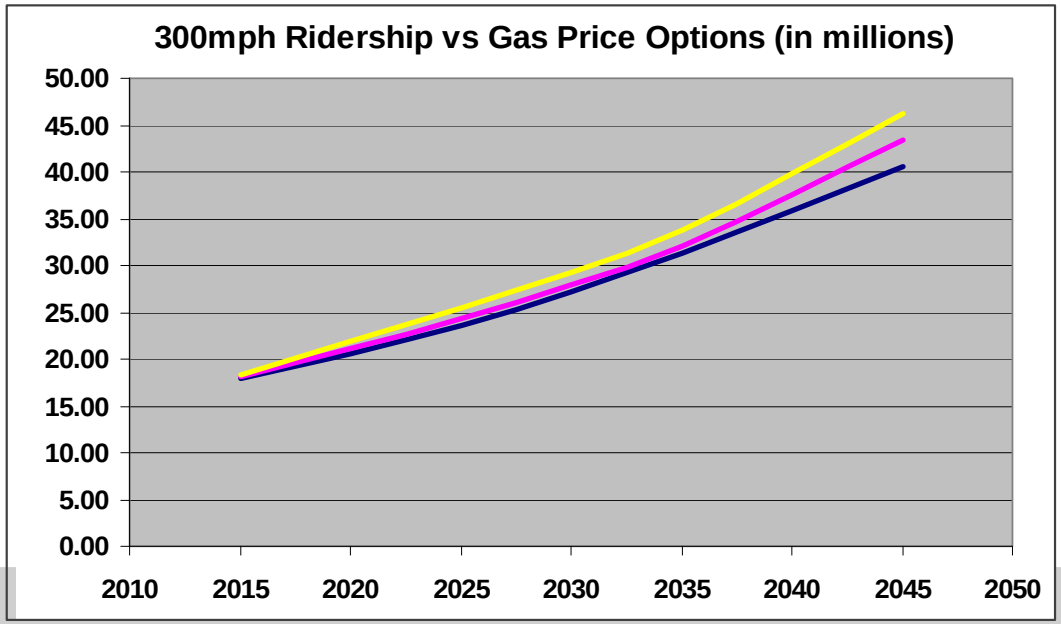
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Ridership Sensitivity
Impact of Gas Prices Scenarios





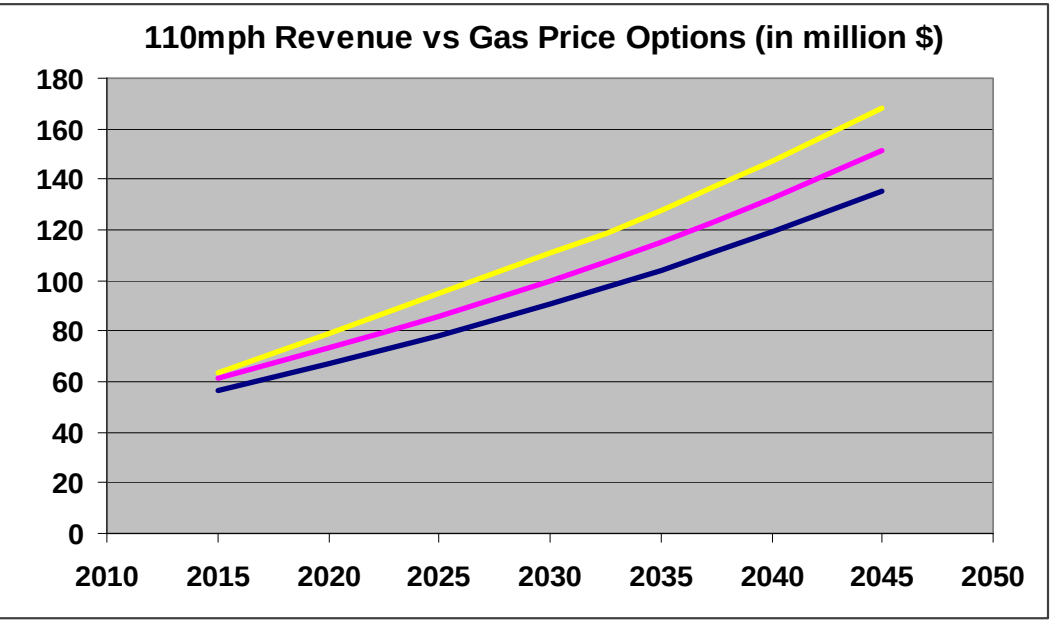
Central Demographic/ Low Gas

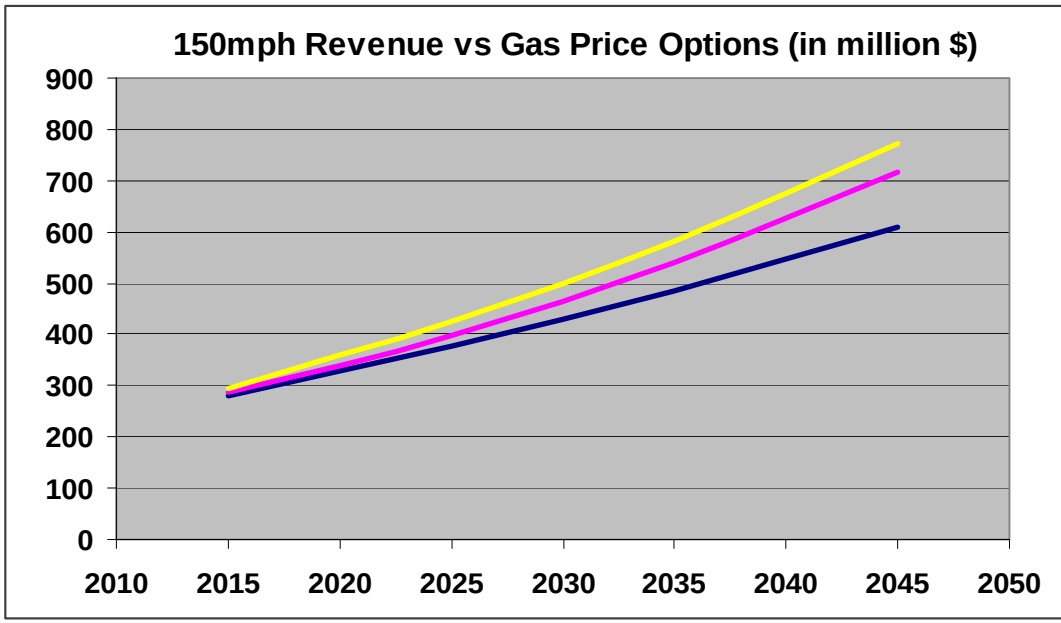


Low = $2+
Central = $3+
High = $4+

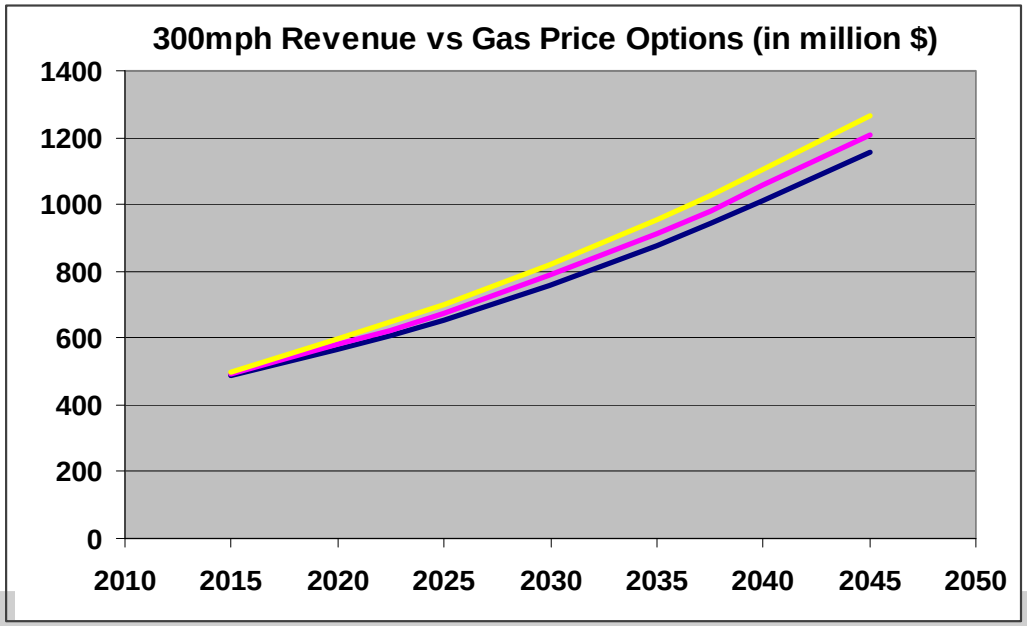
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Revenue Sensitivity
Impact of Gas Prices Scenarios





Central Demographic/ Low Gas

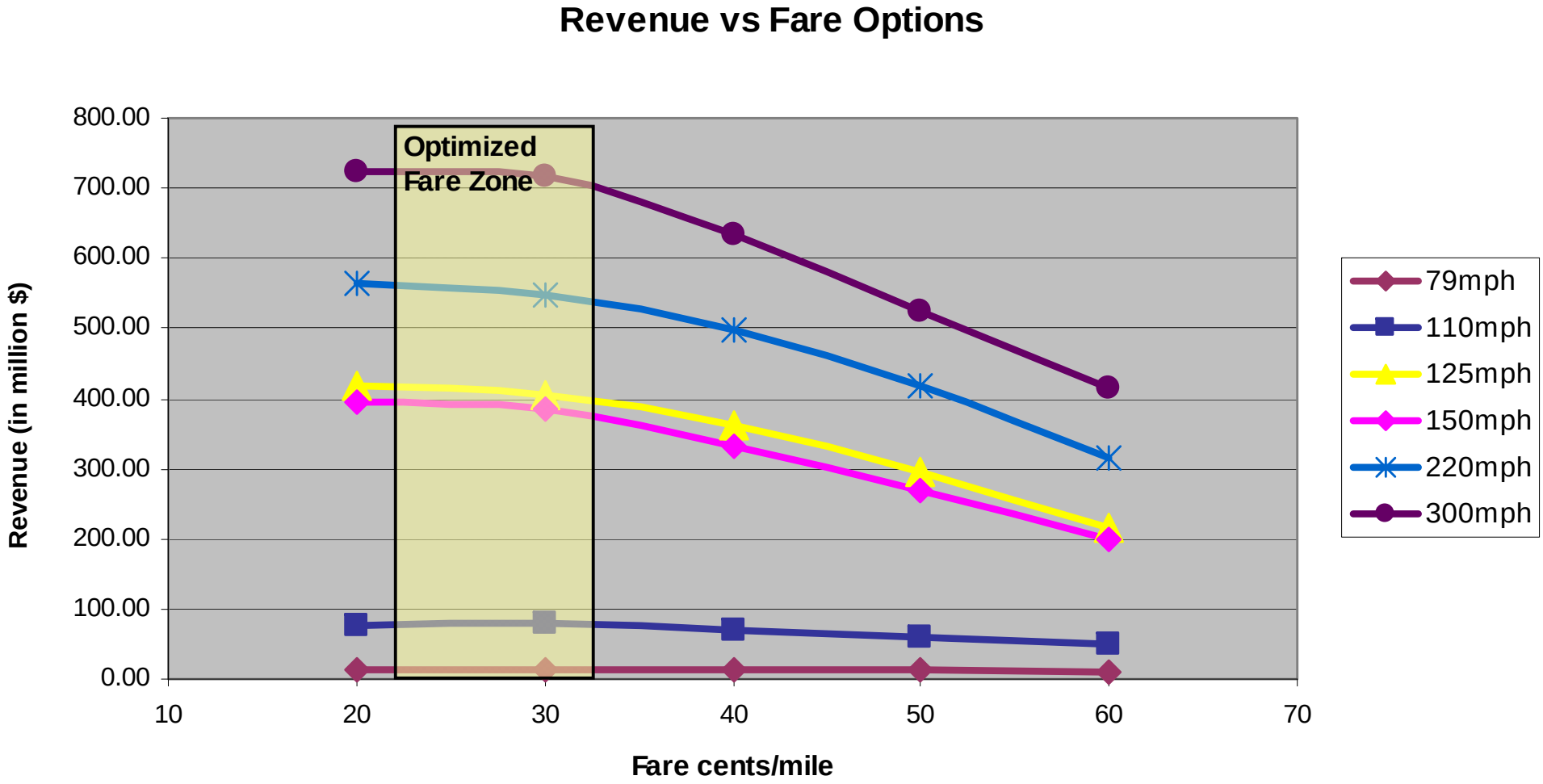


Low = $2+
Central = $3+
High = $4+

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Fare Sensitivity: Impact of Fare Options on Alternative Technologies

(Central Demographic/Low Gas Case, 2025)



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Questions

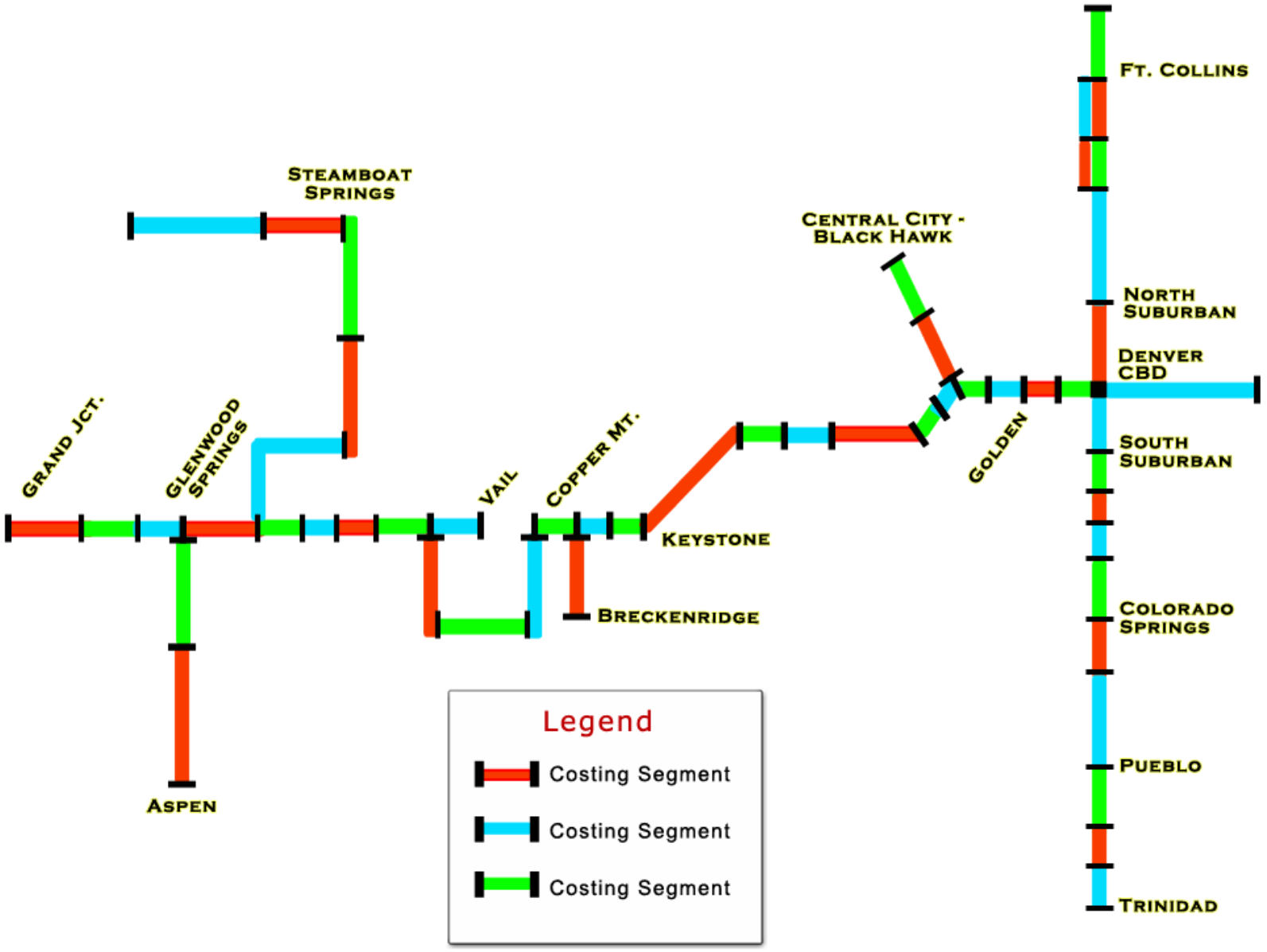
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Capital Costs

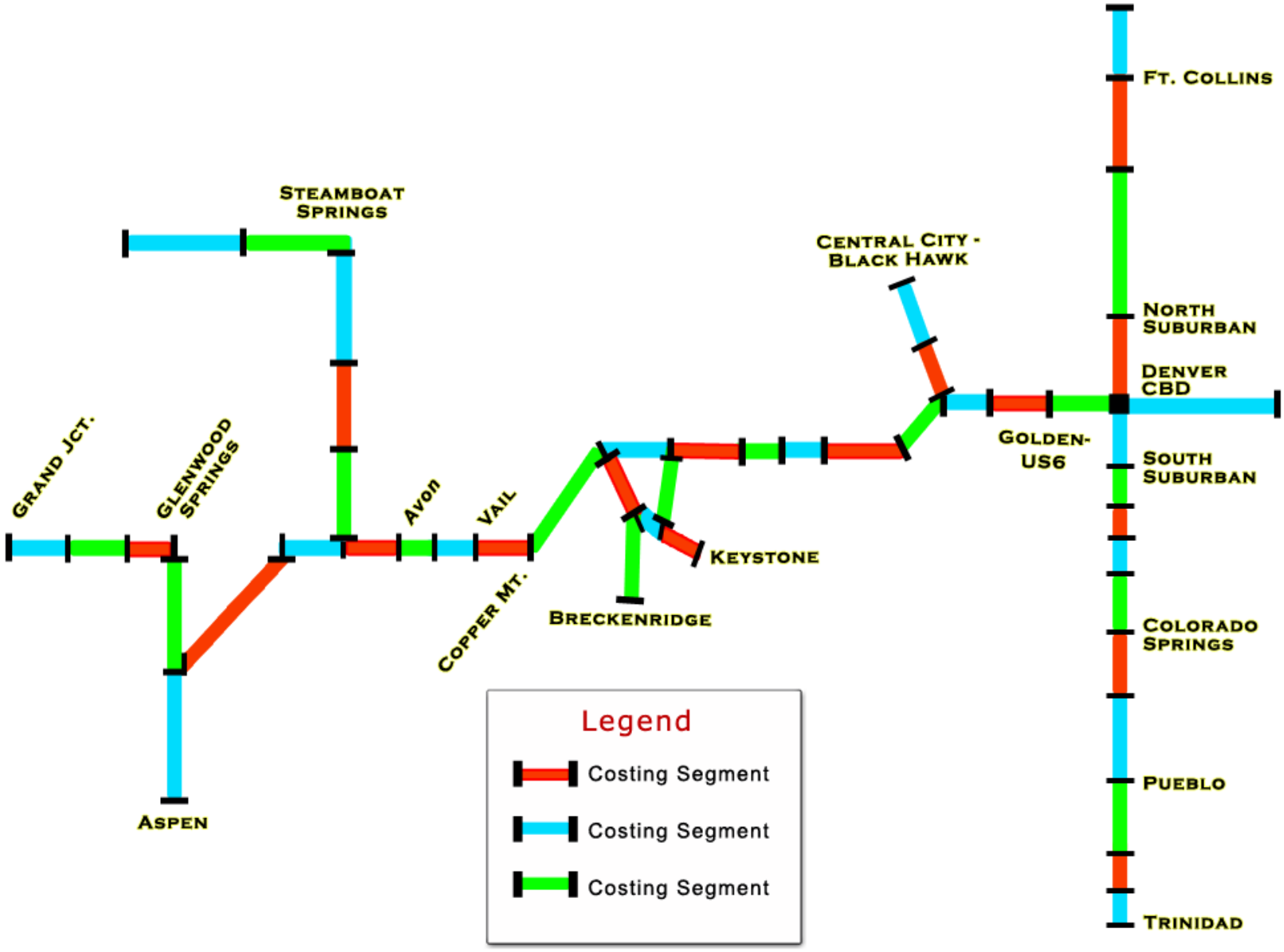
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Unconstrained Rail Network (4%) with Existing Rail, Showing Costing Segments



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Constrained Rail and Maglev Network (7%) with Greenfield, Showing Costing Segments



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Capital by Route and Technology

(Incremental Rail in I-25 Upgrade Costs)

Existing Rail I 25	79mph	110mph
InfraStructure ($Bill)	$3.57	$3.57
Vehicle ($Bill)	$0.18	$0.28
Total ($Bill)	$3.75	$3.85

(Incremental Rail in I-25 Cost per Mile)

Existing Rail I 25	79mph	110mph
Miles	347.50	347.50
Capital Cost per Mile ($Mill)	$10.78	$11.08

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Capital by Route and Technology
(Greenfield Development Costs)

Capital Costs by Route and Technology ($2008 Billions)

Constrained I-70 7% Route / Greenfield I 25	125mph	150mph	220mph	300mph
InfraStructure ($Bill)	$66.94	N/A	$35.59	$75.93
Vehicle ($Bill)	$1.92	N/A	$1.02	$2.44
Total ($Bill)	$68.86	N/A	$36.61	$78.37
Unconstrained I-70 4% Route / Existing Rail I 25	**125mph**	**150mph**	**220mph**	**300mph**
InfraStructure ($Bill)	$72.86	$28.56	$28.56	$82.42
Vehicle ($Bill)	$1.73	$0.66	$0.66	$2.32
Total ($Bill)	$74.59	$29.21	$29.21	$84.73

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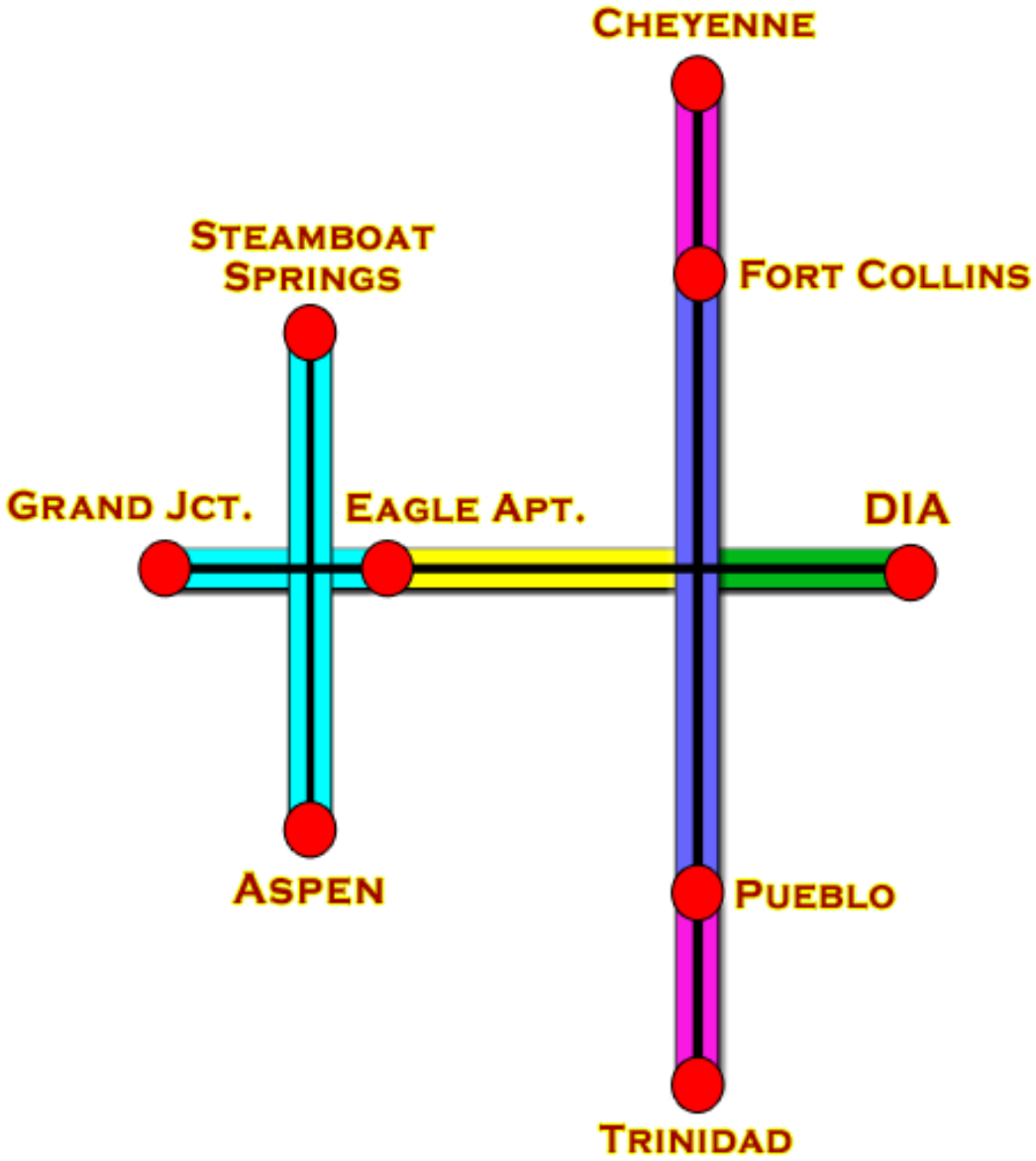
Capital by Route and Technology
(Greenfield Costs per Mile)

Capital Cost per Mile ($2008 Millions)

Constrained I-70 7% Route / Greenfield I 25	125mph	150mph	220mph	300mph
Miles	747.44	N/A	747.44	747.44
Capital Cost per Mile ($Mill)	$92.13	N/A	$48.98	$104.85
Unconstrained I-70 4% Route / Existing Rail I 25	**125mph**	**150mph**	**220mph**	**300mph**
Miles	795.54	795.54	795.54	795.54
Capital Cost per Mile ($Mill)	$93.76	$36.72	$36.72	$106.51

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Major Capital Cost Segments



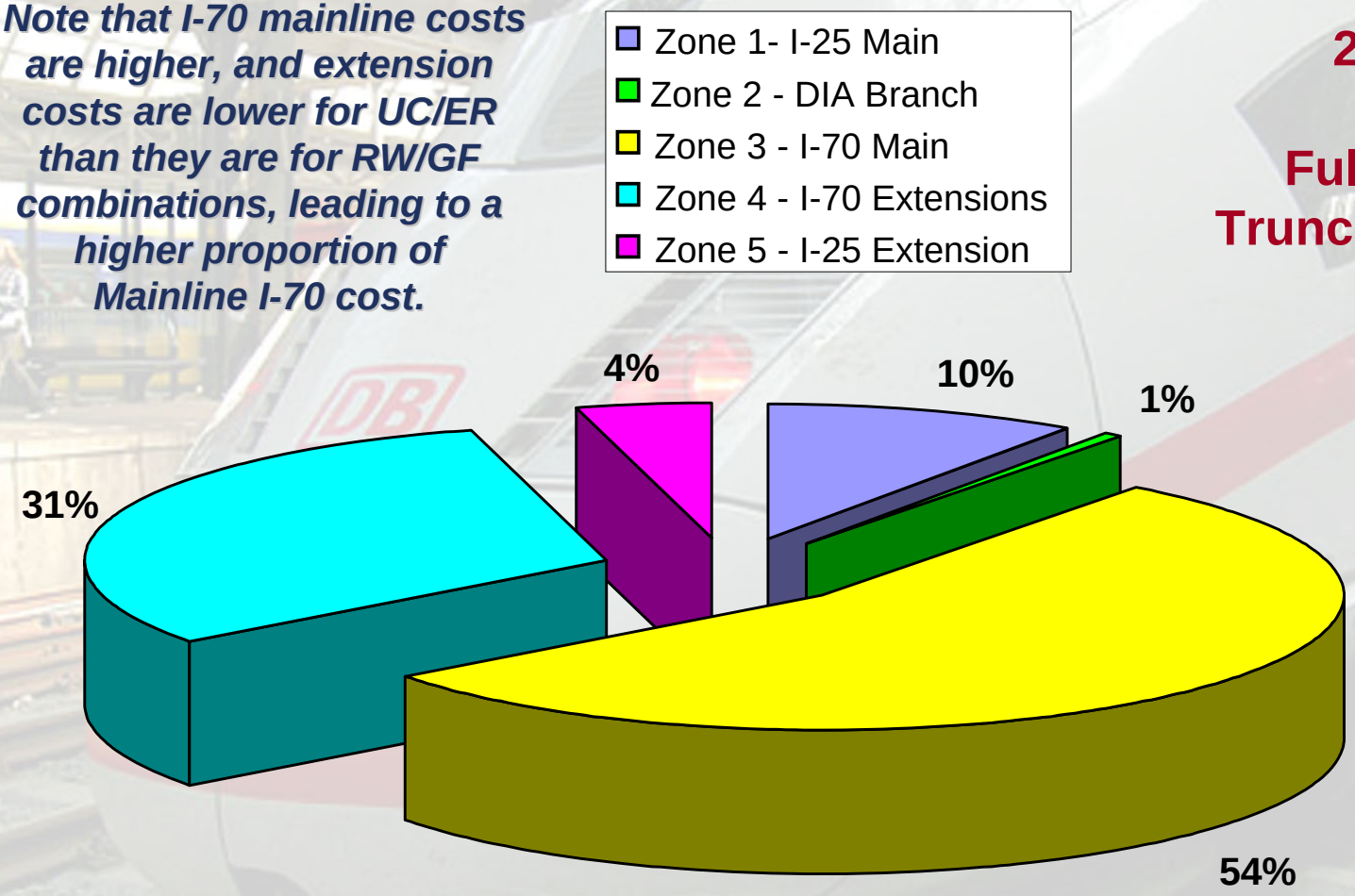
LEGEND

- Zone 1 – I-25 Main
- Zone 2 – DIA Branch
- Zone 3 – I-70 Main
- Zone 4 – I-70 Extensions
- Zone 5 – I-25 Extensions

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150-mph UC/ER Rail Capital Cost by Major Segments

Note that I-70 mainline costs are higher, and extension costs are lower for UC/ER than they are for RW/GF combinations, leading to a higher proportion of Mainline I-70 cost.



2035 Revenues:

Full System $ 586 M
Truncated System $544 M

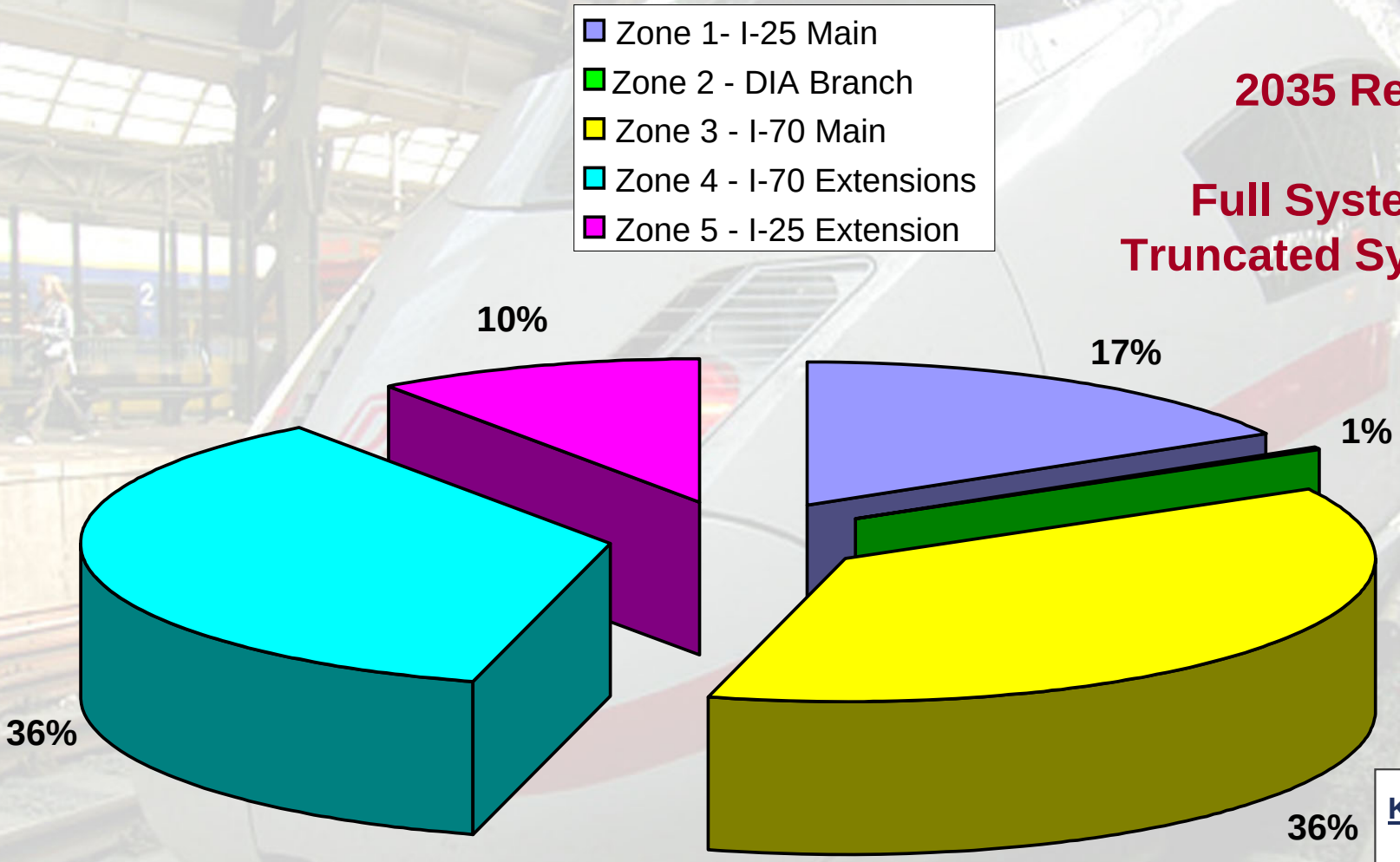
65%of Capital generates
93% of Revenue

Key

ER: I-25 Existing Rail
GF: I-25 Greenfield
RW: I-70 Right of Way 7%
UC: I-70 Unconstrained 4%

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220-mph RW/GF Rail Capital Cost by Major Segments



2035 Revenues:

Full System $ 795 M
Truncated System $ 754 M

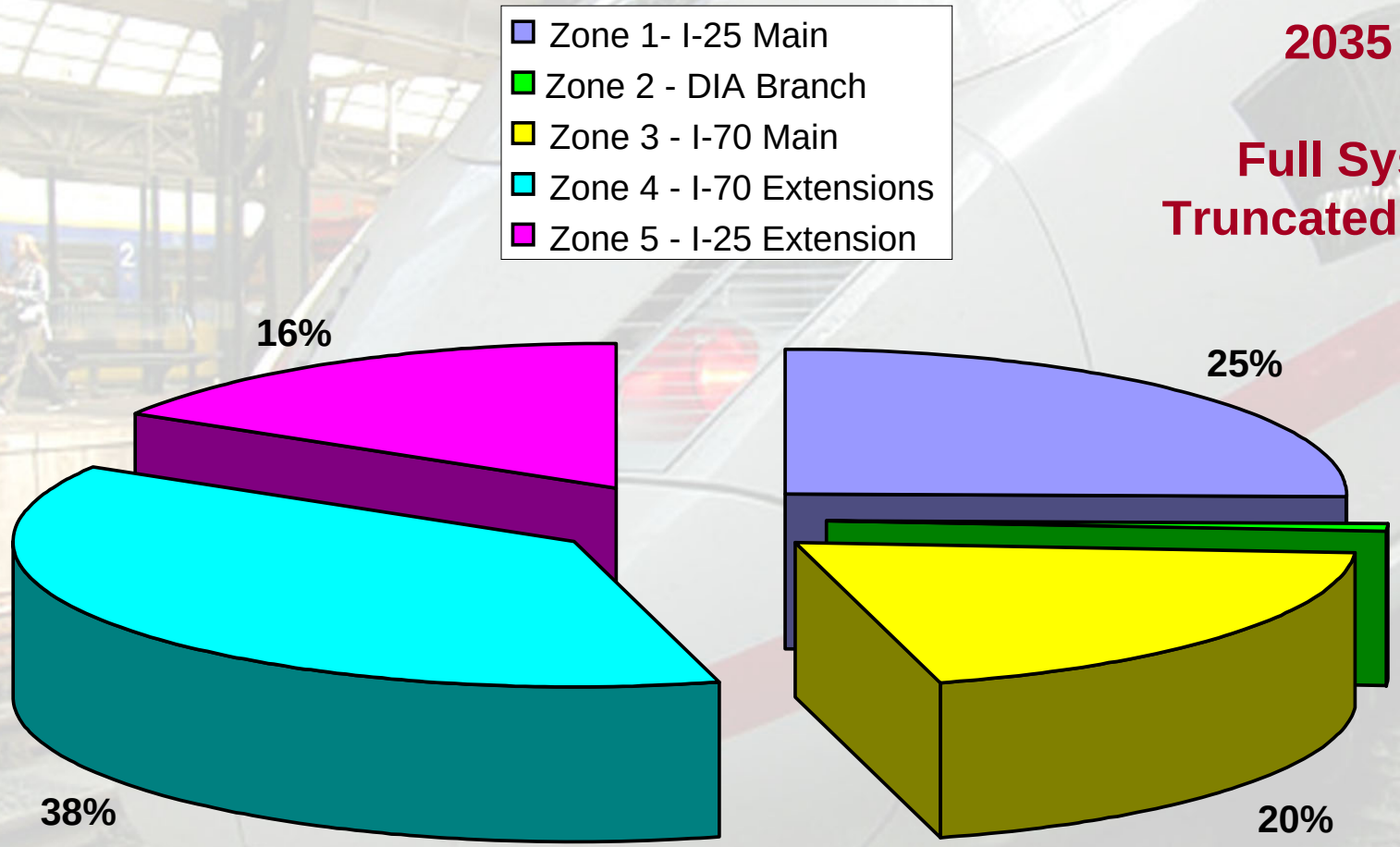
54% of Capital generates
95% of Revenue

Key

ER: I-25 Existing Rail
GF: I-25 Greenfield
RW: I-70 Right of Way 7%
UC: I-70 Unconstrained 4%

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300-mph RW/GF Maglev Capital Cost by Major Segments



2035 Revenues:

Full System $ 893 M
Truncated System $ 874 M

46% of Capital Generates
98% of Revenue

Key

ER: I-25 Existing Rail
GF: I-25 Greenfield
RW: I-70 Right of Way 7%
UC: I-70 Unconstrained 4%

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Comparing Feasibility Study to PEIS Costs

AGS Urban Maglev ($M per mile)

Construction (2002)	$30.4
Escalation Factor (nat'l average)	1.66
Construction (2008)	$50.4
Contingency (30%)	$15.1
Const + Cont	$65.6
Other Costs (28%)	$18.4
I-70 PEIS Comparable Cost	$84.0 K/mile
TEMS/Quandel Range	$72 M to $92 M/mile



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Questions

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Operations and Operating Costs

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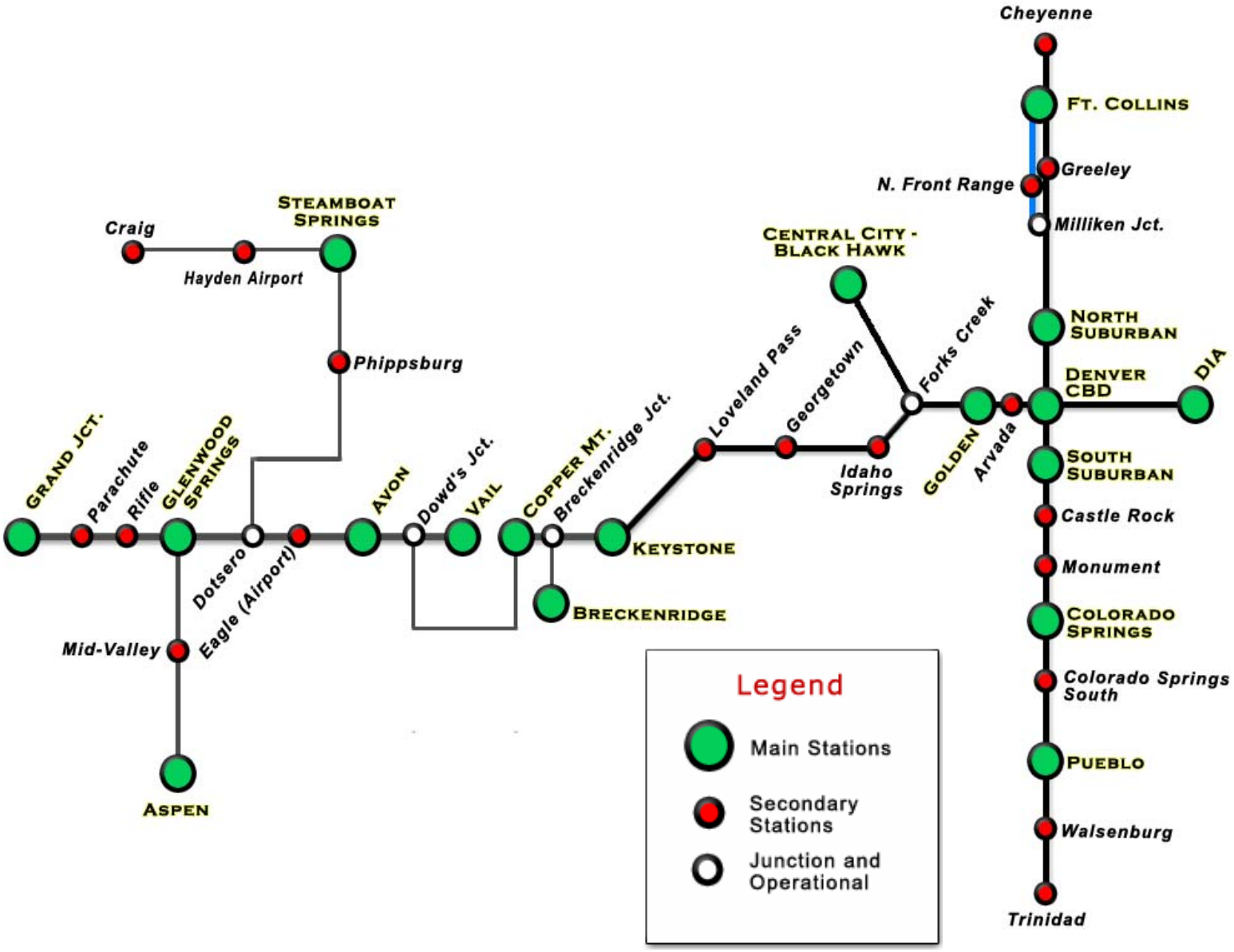
Operating Plans and Costs Developed

- **Six technologies**
 - Four rail technologies
 - 79-mph conventional diesel
 - 110-mph high speed diesel
 - 150-mph loco hauled HSR
 - 220-mph EMU HSR
 - Two maglev technologies
 - 125-mph Colorado maglev (linear induction motor)
 - 300-mph Transrapid (linear synchronous motor)
- **Two alignment options per corridor**
 - I-25 corridor
 - Greenfield
 - Existing rail
 - I-70 corridor
 - I-70 ROW 7% - (high grade)
 - I-70 Unconstrained 4% (low grade)

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Unconstrained Rail Network and Stations

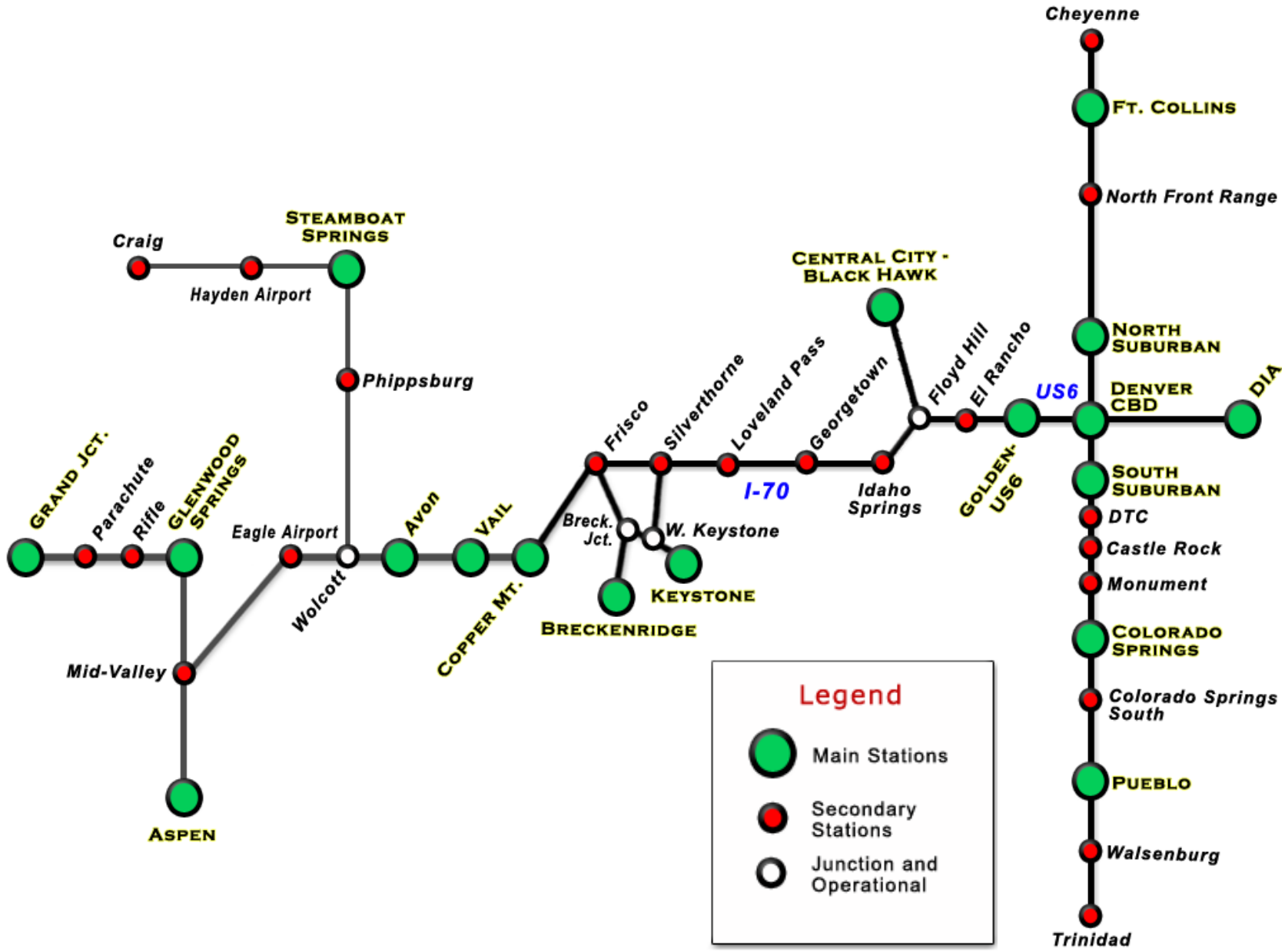
Uses 4% I-70 Unconstrained + Existing Rail I-25



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Constrained Rail and Maglev Network

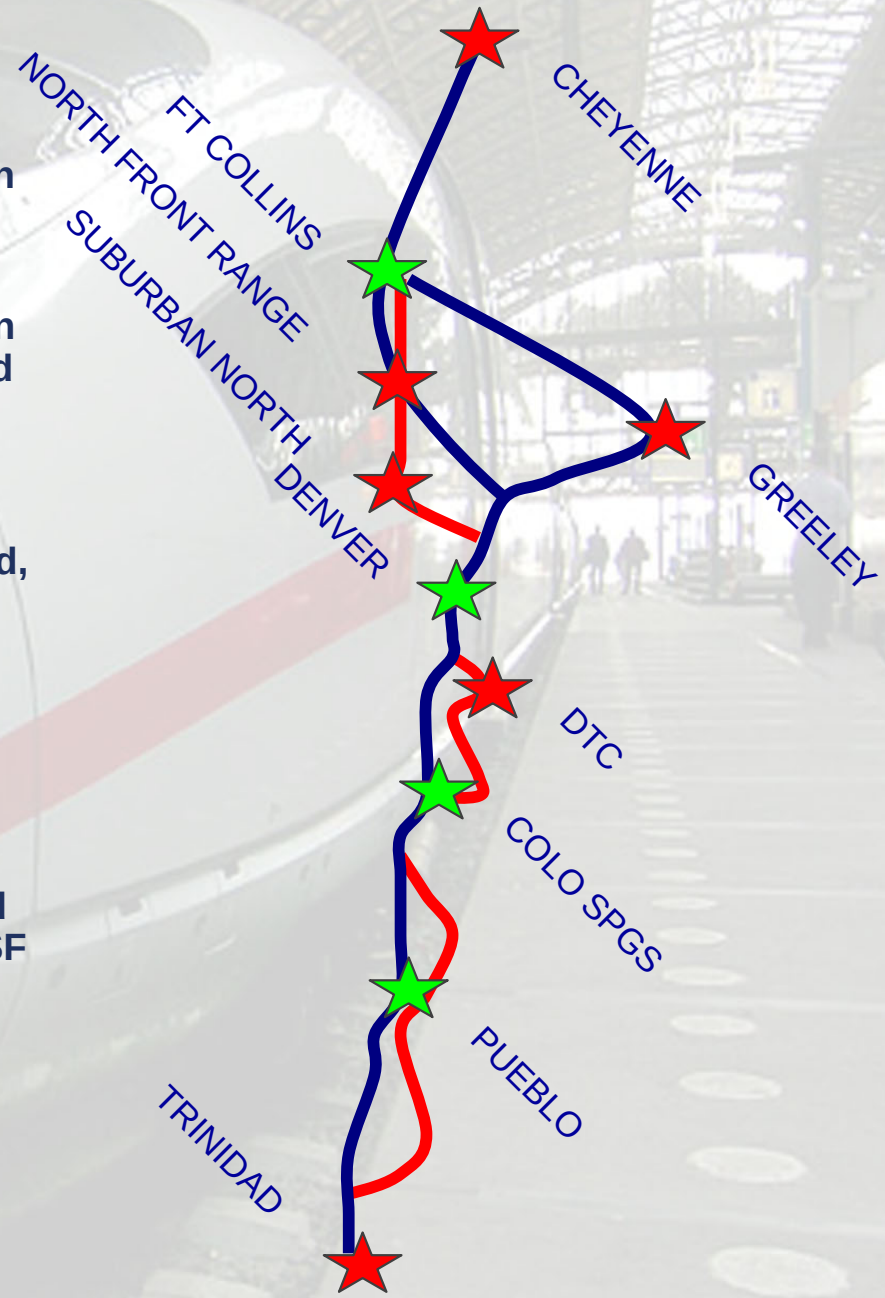
Uses 7% I-70 ROW + I-25 Greenfield



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I-25 North and South

- **Cheyenne to Fort Collins – Weak demographics limit what can be done north of Fort Collins, but perhaps a limited service may be possible based on the strength of I-70 connections.**
- **Fort Collins to Denver Greenfield – The Greenfield's Suburban North station on I-25/E-470 is closer to Boulder/Longmont and picks up stronger ridership, than does the alternative using existing rail.**
- **Fort Collins to Denver Existing Rail – Milliken line's North Front Range station near Loveland, shared with the Greenfield, is very strong. The Milliken Line is also shorter than via Greeley, but using it would require constructing a new Greenfield connection.**
- **Denver to Pueblo Greenfield – Adds a second strong South Suburban station at DTC that drives up ridership. Serving Monument is difficult.**
- **Denver to Pueblo Existing Rail – Would establish a dedicated track by using one of the two existing separate rail lines (ATSF alignment.) Potential problem areas Denver to Littleton, and from Palmer Lake through Colorado Springs.**
- **Pueblo to Trinidad – Although the existing Rail line would be very lightly used if R2C2 occurs but local market demographics don't appear to be strong enough to support a Corridor rail service. A through service to Albuquerque may be possible but not in scope of the current study.**



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I-25 North – Preliminary Operational Assessment: Time and Average Speed

Technology								
Description		79-mph Existing Rail Non tilting	110-mph Existing Rail Tilting	125-mph 7% RW	150-mph 4% UC Tilting	220-mph 7% RW Non tilting	220-mph 7% RW Tilting	300-mph 7% RW
SUMMARY Cheyenne - to - Denver	***Best Combo*** 114 mi	***2:05*** ***55 mph***	***1:27*** ***79 mph***	***1:15*** ***91 mph***	***1:15*** ***91 mph***	***1:13*** ***94 mph***	***1:07*** ***102 mph***	***1:05*** ***105 mph***
Cheyenne - to - Fort Collins	BNSF 46 mi	0:53	0:38	-	0:35	-	-	-
	Via I-25 46 mi	-	-	0:30	-	0:28	0:25	0:23
Fort Collins - to - Denver	Greeley 76 mi	1:21	0:55	-	0:45	-	-	-
	Milliken 68 mi	1:12	0:49	-	0:40	-	-	-
	I-25 68 mi	1:12	0:49	0:45	-	0:45	0:42	0:42
	Boulder 72 mi	1:56	1:22	-	1:19	-	-	-

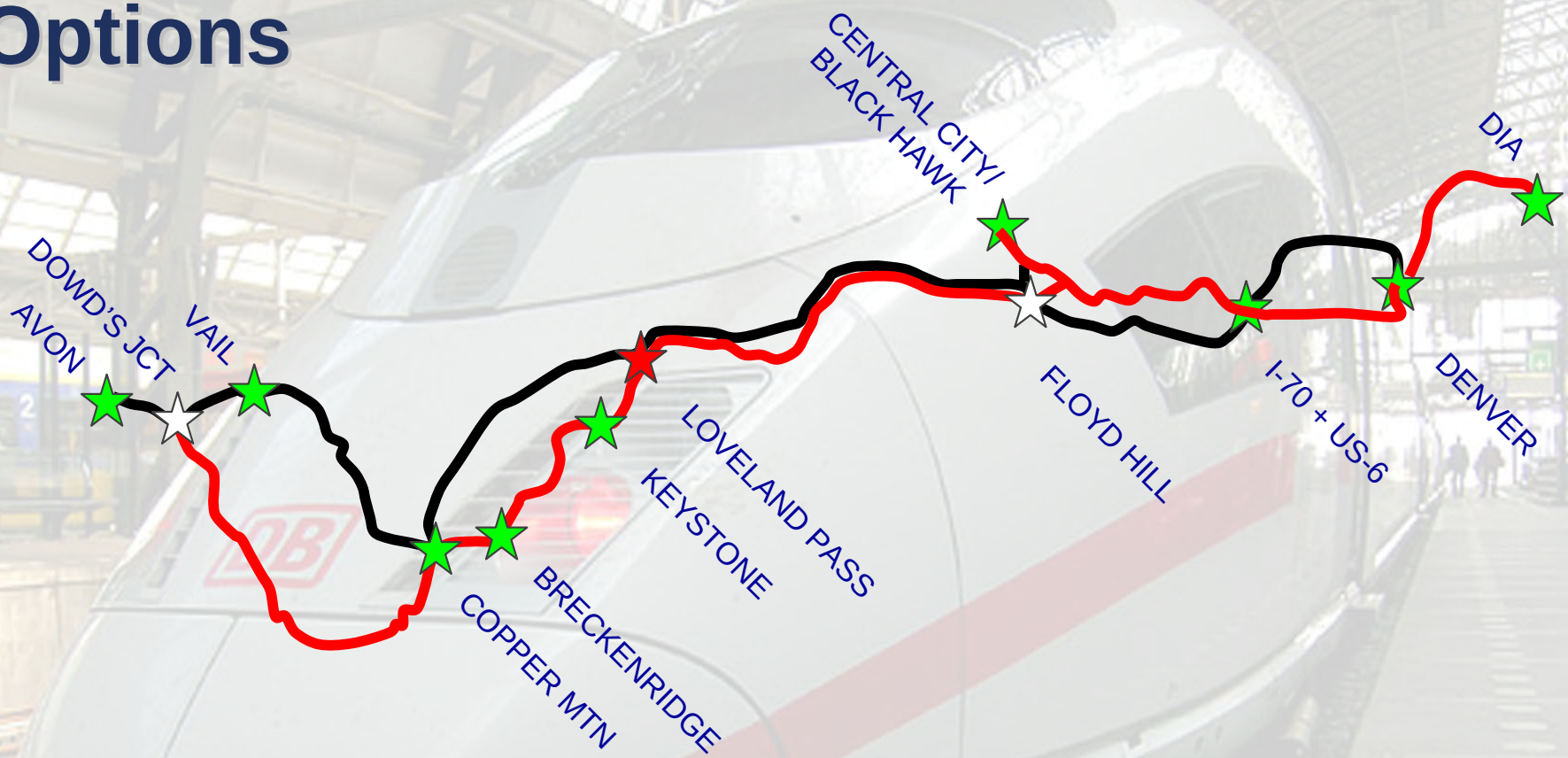
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I-25 South – Preliminary Operational Assessment: Time and Average Speed

Technology		 Conventional Amtrak	 Talgo T21	 Proposed Colorado Maglev	 Eurostar	 ICE EMU		 Transrapid Maglev
Description		79-mph Existing Rail Non tilting	110-mph Existing Rail Tilting	125-mph 7% RW	150-mph 4% UC Tilting	220-mph 7% RW Non tilting	220-mph 7% RW Tilting	300-mph 7% RW
SUMMARY Denver - to - Trinidad	***Joint Line*** 210 mi ***Greenfield*** 231 mi	***4:30*** ***47 mph***	***2:55*** ***72 mph***	***2:17*** ***101 mph***	***2:40*** ***79 mph***	***2:05*** ***111 mph***	***2:00*** ***116 mph***	***1:45*** ***132 mph***
Denver - to - Colo Springs	Joint Line 72 mi	1:45	1:05	-	0:58	-	-	-
	Greenfield 97 mi	-	-	0:47	-	0:45	0:44	0:40
Colo Springs - to - Pueblo	Joint Line 46 mi	1:00	0:35	-	0:32	-	-	-
	Greenfield 48 mi	-	-	0:30	-	0:29	0:27	0:25
Pueblo - to - Trinidad	Joint Line 92 mi	1:45	1:15	-	1:10	-	-	-
	Greenfield 86 mi	-	-	1:00	-	0:51	0:49	0:40

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I-70 East of Avon– Comparative Route Options



- **DIA to Denver – Follow Brush Line and Greenfield to DIA Airport**
- **Denver to US-6/I-70 – US-6 is the fastest alignment but probably also the most expensive.**
- **US-6/I-70 to Floyd Hill – Choice between heavy grades via El Rancho or sharp curves/tunnels in the Clear Creek canyon.**
- **Floyd Hill to Loveland Pass – "Corridor"alignment parallels I-70 with better grades using a tunnel up to Silver Plume.**
- **Loveland Pass to Copper – "Greenfield" alignment south of Dillon Lake serves Keystone and Breckenridge directly.**
- **Copper to Dowd's– I-70 over Vail Pass has steep grades; Pando alternative needs a branch line to Vail.**
- **Dowd's Jct to Avon –Existing rail to Avon.**

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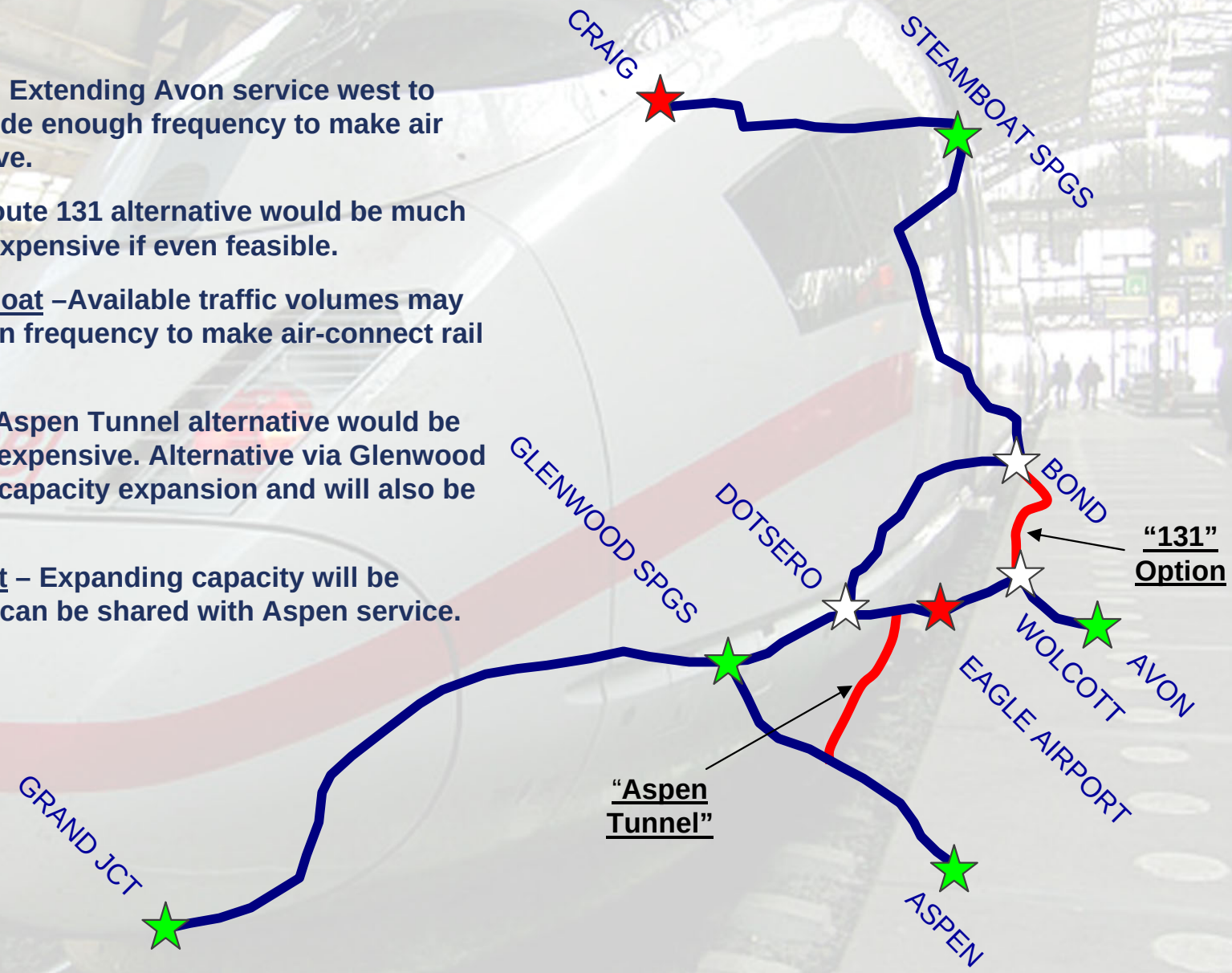
I-70 East of Avon – Preliminary Operational Assessment: Time and Average Speed

Technology						
Description		125-mph 7% RW	150-mph 4% UC Tilting	220-mph 7% RW Non tilting	220-mph 7% RW Tilting	300-mph 7% RW
SUMMARY DIA - to - Avon	***I-70*** 135 mi	***2:13*** ***61 mph***	***2:25*** ***56 mph***	***2:36*** ***52 mph***	***2:25*** ***56 mph***	***2:10*** ***62 mph***
DIA - to - Denver	BNSF 23 mi	0:16	0:13	0:14	0:13	0:13
Denver - to - Copper	I-70 80 mi	1:20	1:30	1:35	1:30	1:20
Copper - to - Vail	I-70 22 mi	0:25	0:27	0:30	0:27	0:25
Vail - to - Avon	UP RR 10 mi	0:12	0:15	0:17	0:15	0:12
Denver - to - Black Hawk	US-6 35 mi	0:53	0:54	1:00	0:54	0:53

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I-70 West of Avon– Route Options

- **Eagle Airport to Avon** – Extending Avon service west to Eagle would likely provide enough frequency to make air connect service attractive.
- **Avon to Steamboat** – Route 131 alternative would be much faster, but will be very expensive if even feasible.
- **Eagle Airport to Steamboat** –Available traffic volumes may not support enough train frequency to make air-connect rail service attractive.
- **Avon/Eagle to Aspen** – Aspen Tunnel alternative would be much faster but is very expensive. Alternative via Glenwood Canyon requires UPRR capacity expansion and will also be expensive.
- **Avon/Eagle to Grand Jct** – Expanding capacity will be expensive, but the cost can be shared with Aspen service.



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I-70 West of Avon – Preliminary Operational Assessment: Time and Average Speed

Technology						
Description		125-mph 7% RW	150-mph 4% UC Tilting	220-mph 7% RW Non tilting	220-mph 7% RW Tilting	300-mph 7% RW
Avon - to - Grand Jct	UP RR 141 mi	***1:42*** *83 mph*	***1:45*** *81 mph*	***1:55*** *74 mph*	***1:45*** *81 mph*	***1:37*** *87 mph*
Avon - to - Glenwood	UP RR 52 mi	0:42	0:45	0:50	0:45	0:42
Glenwood - to - Grand Jct	UP RR 89 mi	1:00	1:00	1:05	1:00	0:55
Avon - to - Steamboat	Wolcott 90 mi	1:20	1:30	1:40	1:30	1:20
	Dotsero 133 mi	2:10	2:15	2:25	2:15	2:10
Avon - to - Aspen	UP RR 89 mi	1:15	1:22	1:38	1:22	1:15
	Tunnel 65 mi	0:50	0:53	1:00	0:53	0:50

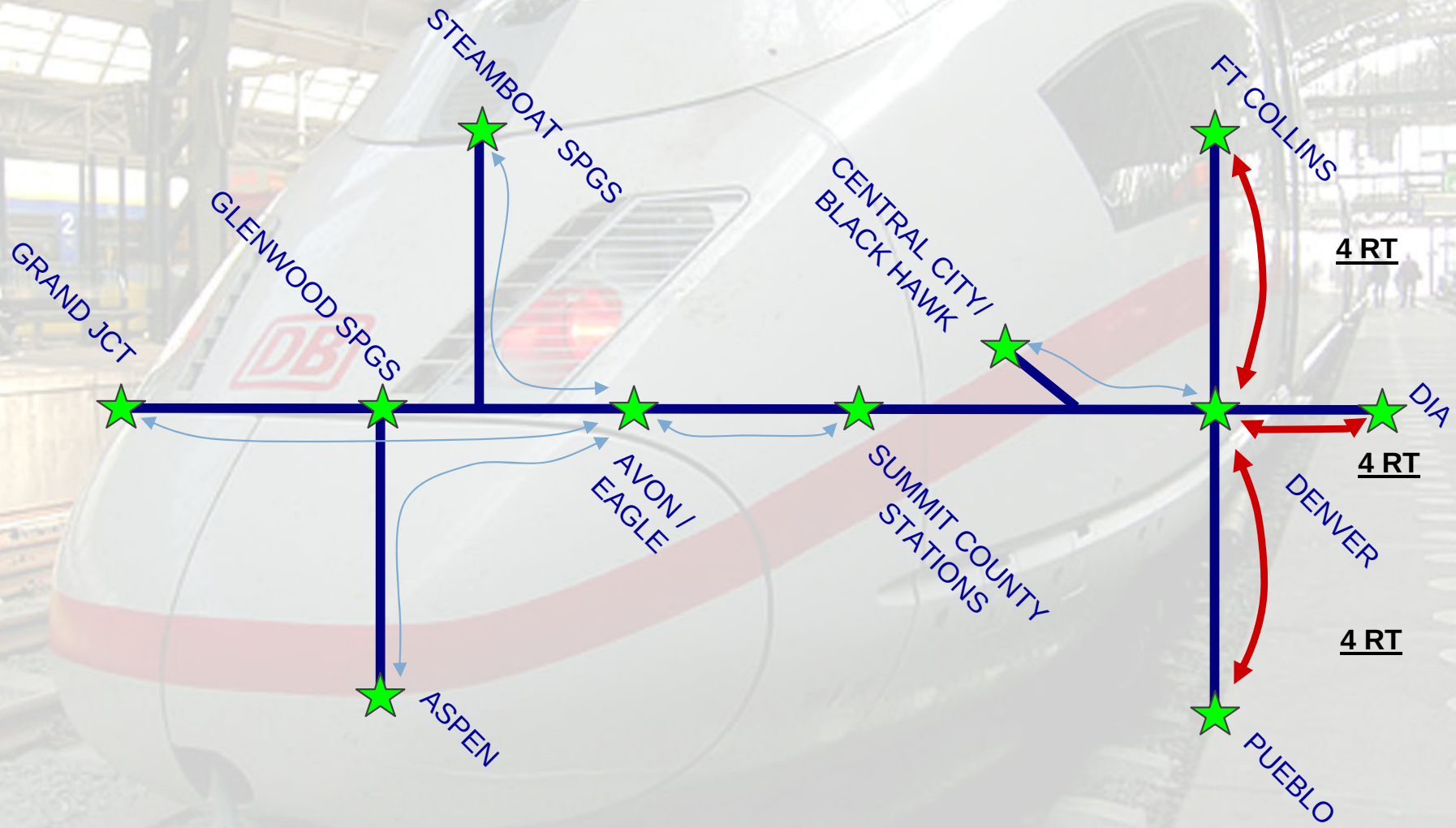
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Train Frequency/Operations Analysis

- **The following slides show the Base Frequency assumptions that were used for development of Operating Costs**
 - Because of expected weaker demand, Base Frequencies were cut in half on the western branch lines to Steamboat, Grand Junction and Aspen.
 - For consistency with the Demand Forecast, this is the minimum frequency that was operated for cost development purposes.
 - However, some segments, primarily from Denver to Vail, had very strong demand that required operation of *additional trains* for capacity reasons. These charts show where the additional trains were added.

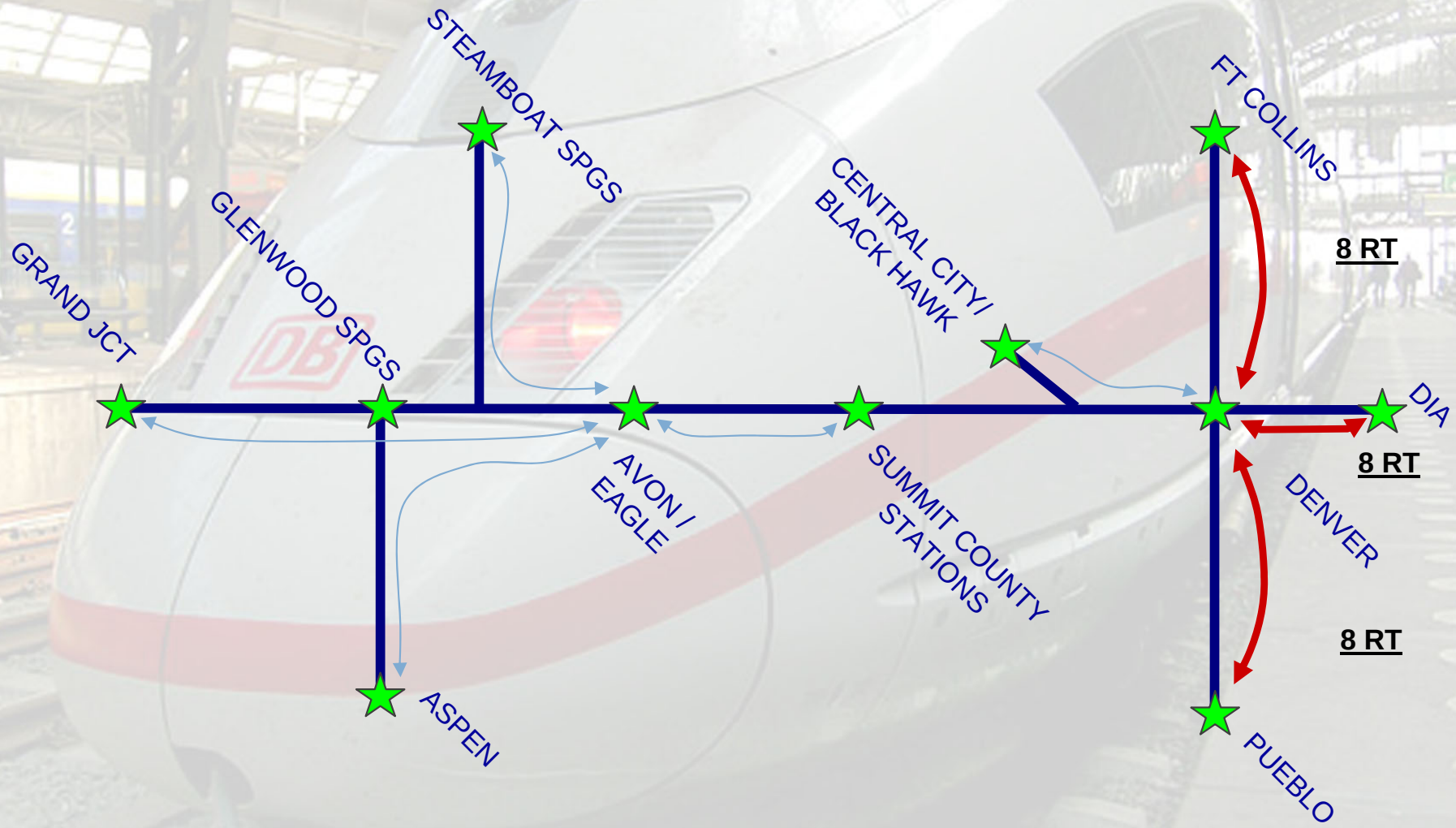
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Initial Screening – Rail Operating Plan
79-mph: Base Freq = 4 RT/Day



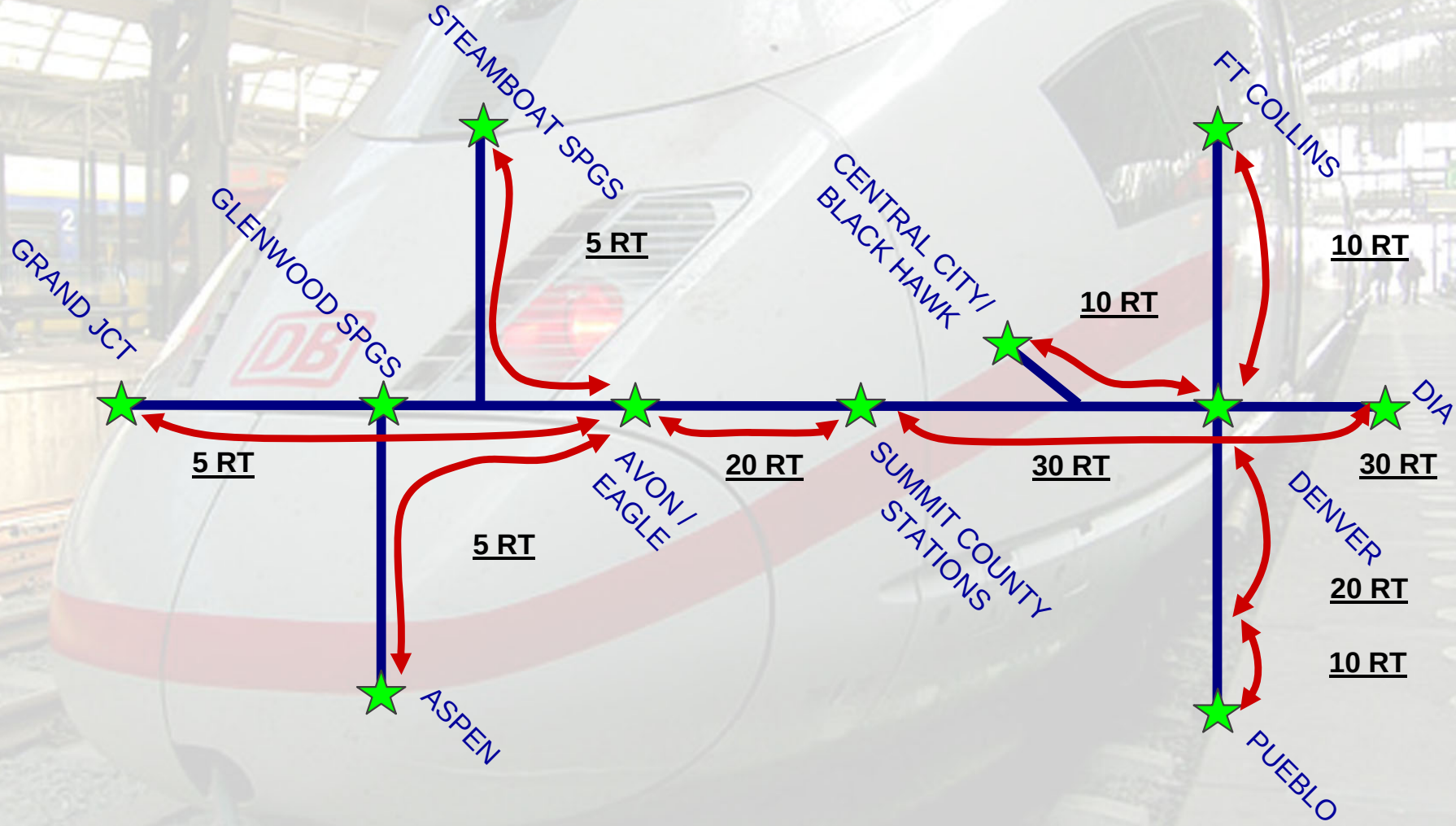
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Initial Screening – Rail Operating Plan
110-mph: Base Freq = 8 RT/Day



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Initial Screening – Rail Operating Plan
125-mph: Base Freq = 10 RT/Day (7%)

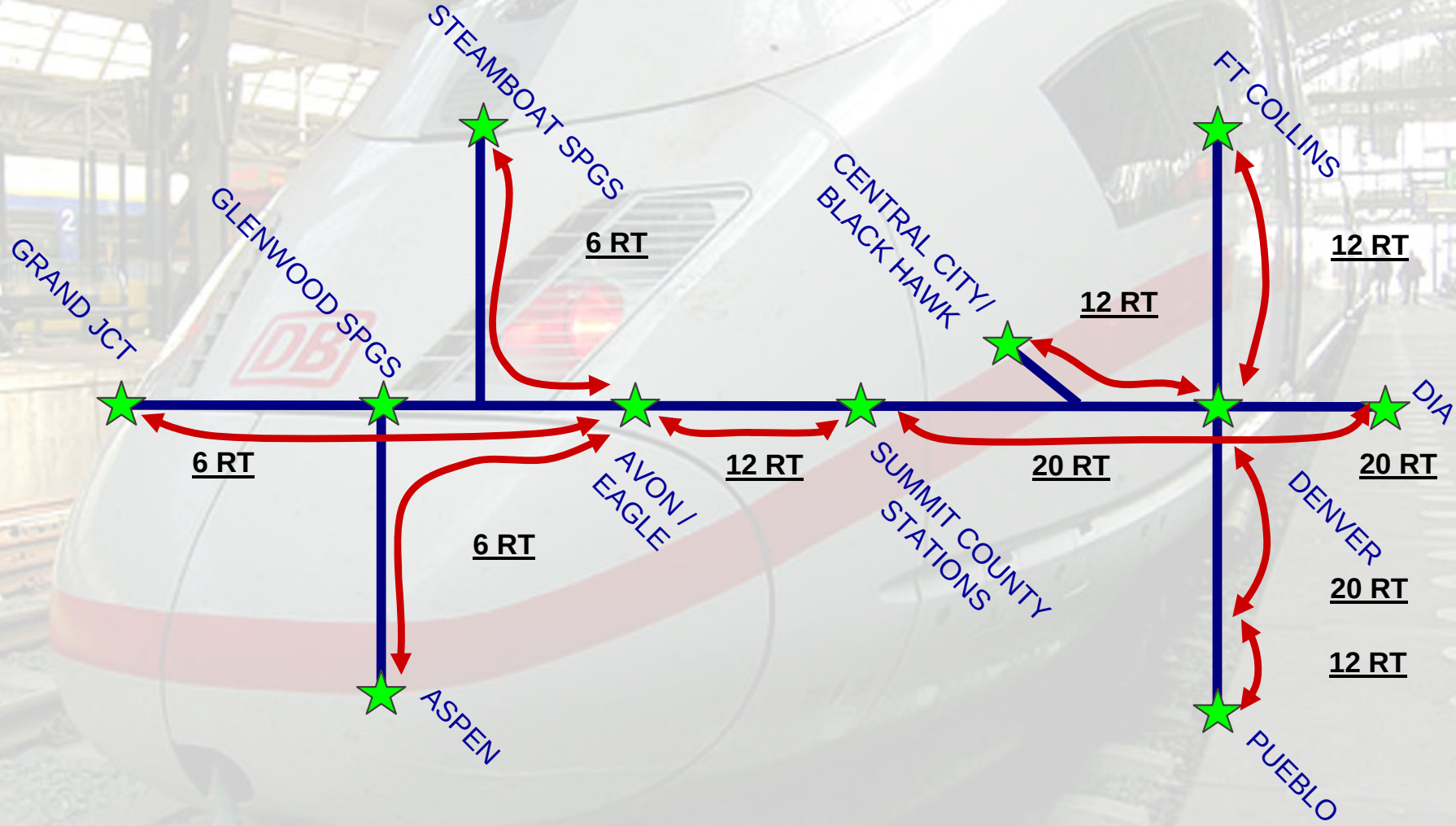


*** Simulated Frequency is ½ Base on the three branch lines west of Eagle.**

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Initial Screening – Rail Operating Plan

150-mph: Base Freq = 12 RT/Day (4%)

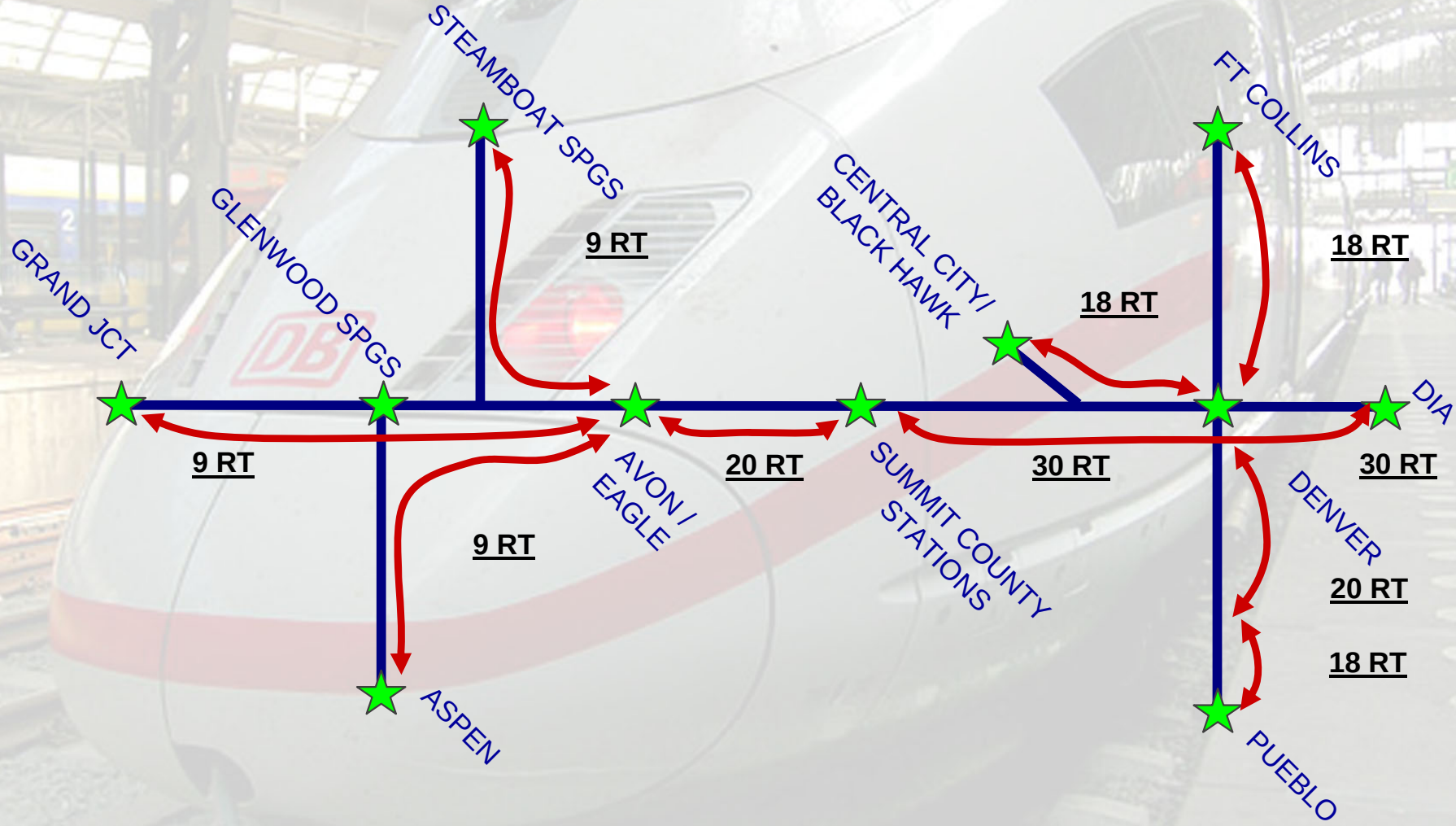


*** Simulated Frequency is ½ Base on the three branch lines west of Eagle.**

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Initial Screening – Rail Operating Plan

220-mph: Base Freq = 18 RT/Day – (7%)

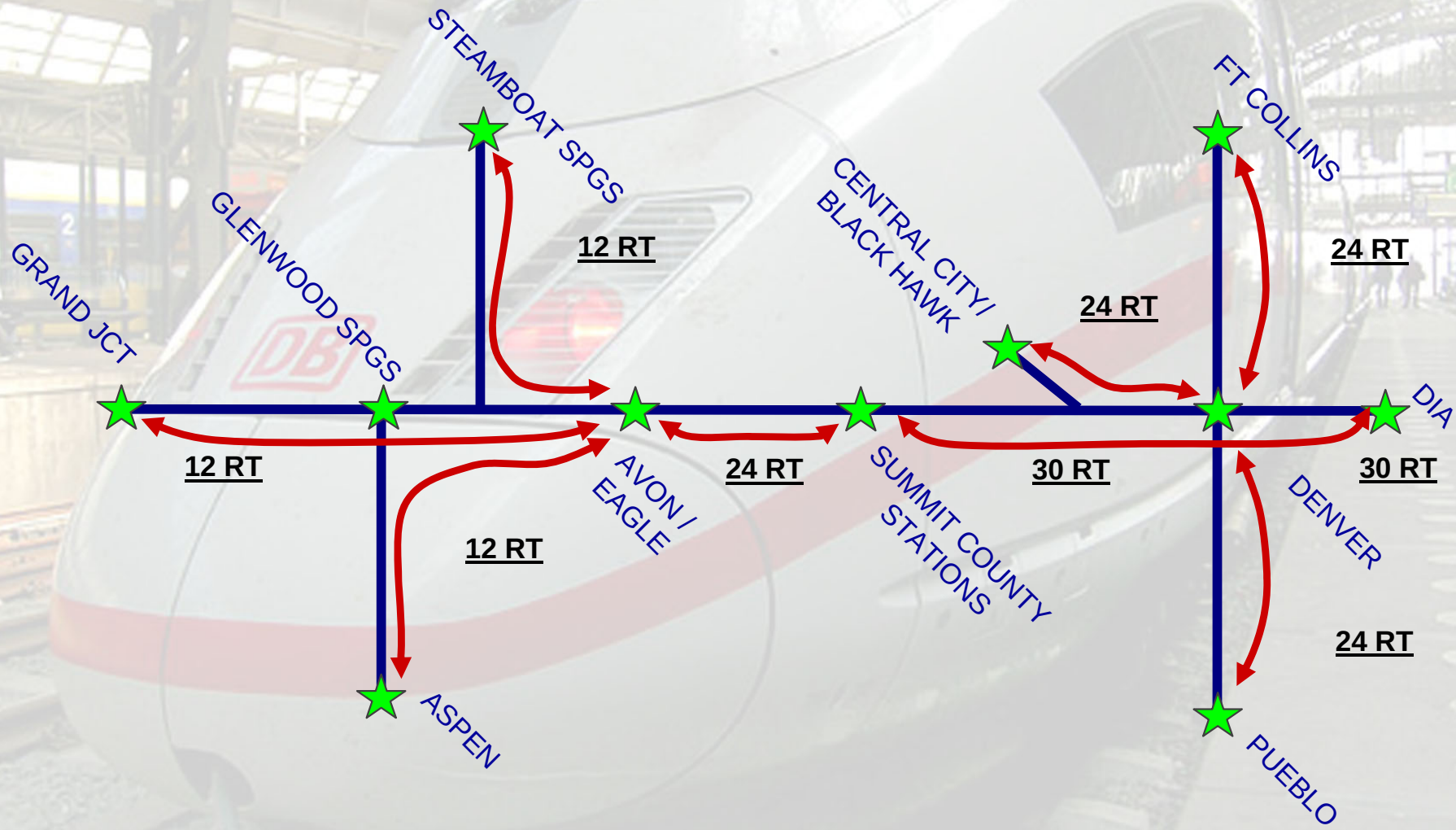


*** Simulated Frequency is ½ Base on the three branch lines west of Eagle.**

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Initial Screening – Rail Operating Plan

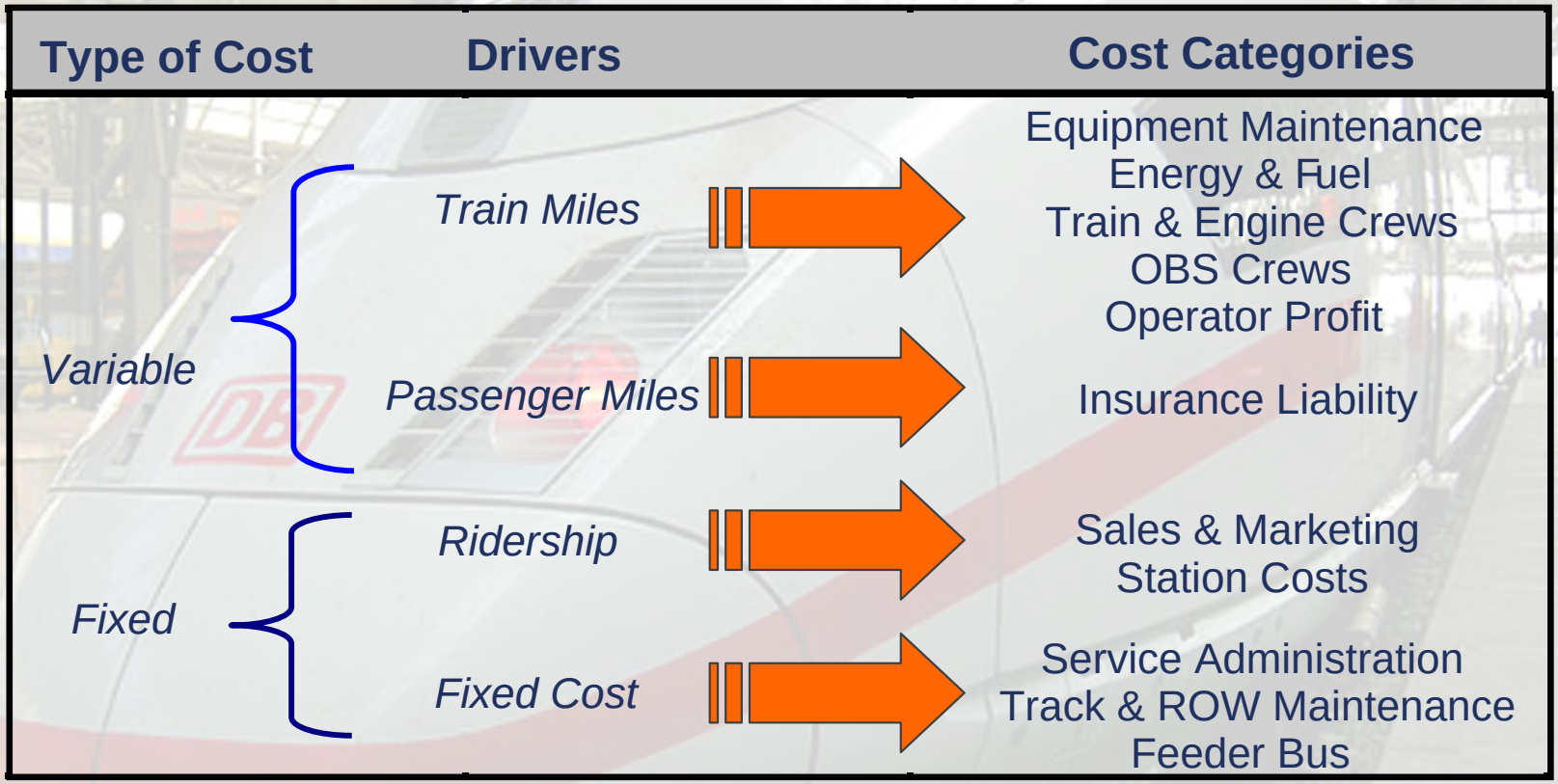
300-mph: Base Freq = 24 RT/Day – (7%)



*** Simulated Frequency is ½ Base on the three branch lines west of Eagle.**

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Operating Cost Categories



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Operating Cost Comparison

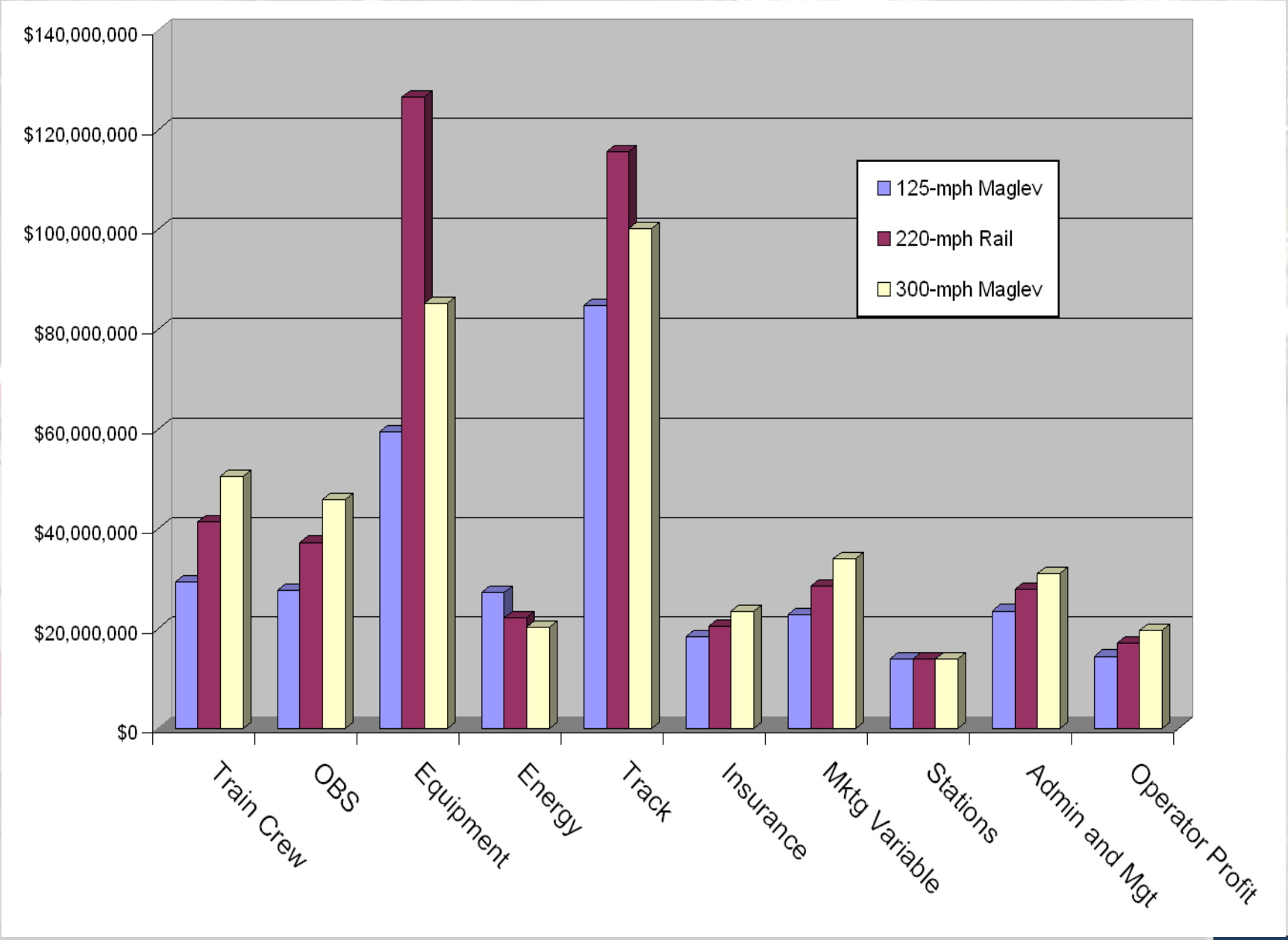
- Costs that depend on technology/speed/demand are estimated to reflect differences
- Costs that reflect overhead/administration/insurance/crews are treated the same.

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Maglev vs. Rail Operating Cost Comparison

I-70 ROW (7%) + I-25 Greenfield Network, Year 2025 Projection

Example Results



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Example Results

- **Technology-dependent Maglev costs considered lower than Rail on a unit basis**
 - Maglev Track and Equipment costs both lower than rail
 - 125-Maglev Energy higher than rail; 300-Maglev lower
- **Other maglev costs are treated as equivalent to rail. 125-Maglev total costs are lower, 300-Maglev higher because of Ridership-driven variable cost components.***
 - Administration
 - Train and on board crew
 - Stations
 - Insurance

This is considered a favorable treatment of Maglev. For example the Baltimore-Washington Maglev study added a 40% contingency to all Maglev operating costs, and assessed Insurance cost equivalent to 25% of total operating cost. In contrast, Insurance expense here reflects just 5% of operating cost. The requirements of Apples-to-Apples comparison require a more favorable treatment of Maglev costs than many of the previous pure Maglev studies have supported.

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Questions

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Preliminary Financial Analysis

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Workshop Criteria

1) Both *Financial* and *Cost Benefit* Preliminary Estimates were based on:

- 2035 Central Gas
- 2035 Revenues, Consumer Surplus, Emissions & Resource Savings (e.g., Energy)
- 2035 Operating Costs
- 6.2 percent annual Capital Charge approximate PV

2) Why

- After construction
- Stable financial flows

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Initial Operating Ratio Screening

- **Observation**
 - **Low Capital Investment** alternatives (e.g. 79-mph, 110-mph) typically have the most difficulty satisfying Operating Ratio criteria.
 - **High Capital Investment** alternatives (e.g. 125-mph and up) seldom have a problem with the Operating Ratio criteria, but if Capital costs are too high, they may run into trouble with the Cost Benefit criteria.
 - **The Challenge** is to find a "Sweet Spot" that achieves a Positive Operating ratio without spending too much Capital up-front.
- **This section will show the Operating Ratio screening of 79-mph and 110-mph alternatives.**
- **All RMRA options for 125-mph service or better developed Positive Operating Ratios. These options will be subjected to the Cost Benefit test in the next section.**

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Operating Ratio Results: Full Network Options for Existing Rail on I-25

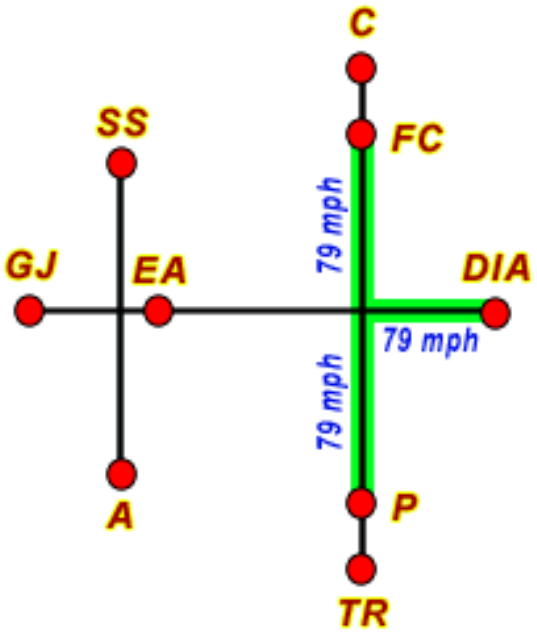
	79-mph Full	110-mph Full
Revenue	36.46	117.00
Operating Costs	68.94	132.36
2035 Op Ratio	**0.53**	**0.88**

***All Untruncated I-25 Options fail* the Operating Ratio test. Too many empty train-miles are being run to cover operating cost.**

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79-mph/110-mph Existing Rail Truncated Phase 1 Alternatives

Option 1: 79-mph

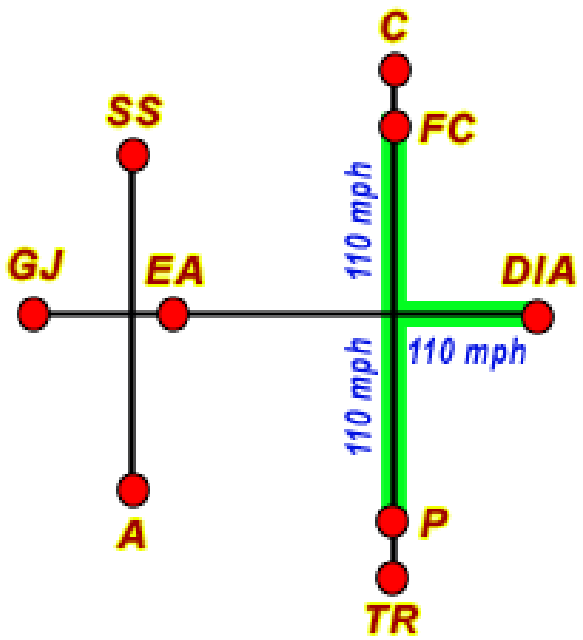


OPTION 1: Capital Costs

I-25:	2.7	Billion
I-70:	/	Billion
Vehicle:	0.1	Billion
TOTAL:	**2.9**	**Billion**

Only Serves I-25

Option 2: 110-mph



OPTION 2: Capital Costs

I-25:	2.7	Billion
I-70:	/	Billion
Vehicle:	0.2	Billion
TOTAL:	**2.9**	**Billion**

Only Serves I-25

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Operating Ratio Results: Truncated Network Options for Existing Rail on I-25

	79-mph Truncated	110-mph Truncated
Revenue	33.29	107.64
Operating Costs	51.74	94.68
2035 Op Ratio	**0.64**	**1.14**

***All 79-mph Options fail** the Operating Ratio test. Even a truncated 79-mph service cannot produce enough revenue to cover its operating costs.*

The truncated 110-mph Option survives** because the service is fast enough to attract higher-fare business travel, as well as recreational and leisure travel. This service is able to generate enough revenue to cover its operating cost and make a small contribution to Capital. **This will be the only Stand-Alone, Front Range Existing Rail option carried forward into Cost Benefit screening.

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Operating Ratio Results: Full-Network Options using I-25 and I-70

	125-mph (7% Grade) Full	150-mph (4% Grade) Full	220-mph (7% Grade) Full	300-mph (7% Grade) Full
Revenue	600.66	586.33	795.79	893.10
Operating Costs	373.10	416.09	484.43	448.38
2035 Op Ratio	**1.61**	**1.41**	**1.64**	**1.99**

All I-70 and I-25 Full Network Options Pass *the Operating Ratio test, even though some segments are lightly used.*

This simply implies that the contribution from the main line segments is sufficient to offset losses on some lightly used pieces.

"Truncation" of lightly used segments is not required by the Operating Ratio criteria, but because of high Capital Costs, these segments fail the Cost Benefit test.

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Preliminary Economic Analysis

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Basis for Developing Alternatives

FRA criteria are being applied to assess the Economic Feasibility of each alternative, in a four-step process, as follows:

1. **"Initial" alternatives** follow the matrix of rail network/technology combination as defined in the Alternatives Development Report.
2. **"Truncated" alternatives** were developed that reduce costs by eliminating service north of Fort Collins, south of Pueblo, and west of Eagle Airport.
3. **To further develop choices, "Mix and Match" networks were developed that combine different technologies** on different portions of the network, to restore some level of service to some of the cities that were "truncated" in Step 2, as well as to further improve the economic performance of the system.
4. **Stakeholder input is needed to ensure that all reasonable options have been screened in Steps 1-3.** The best alternatives will be taken forward for further evaluation.

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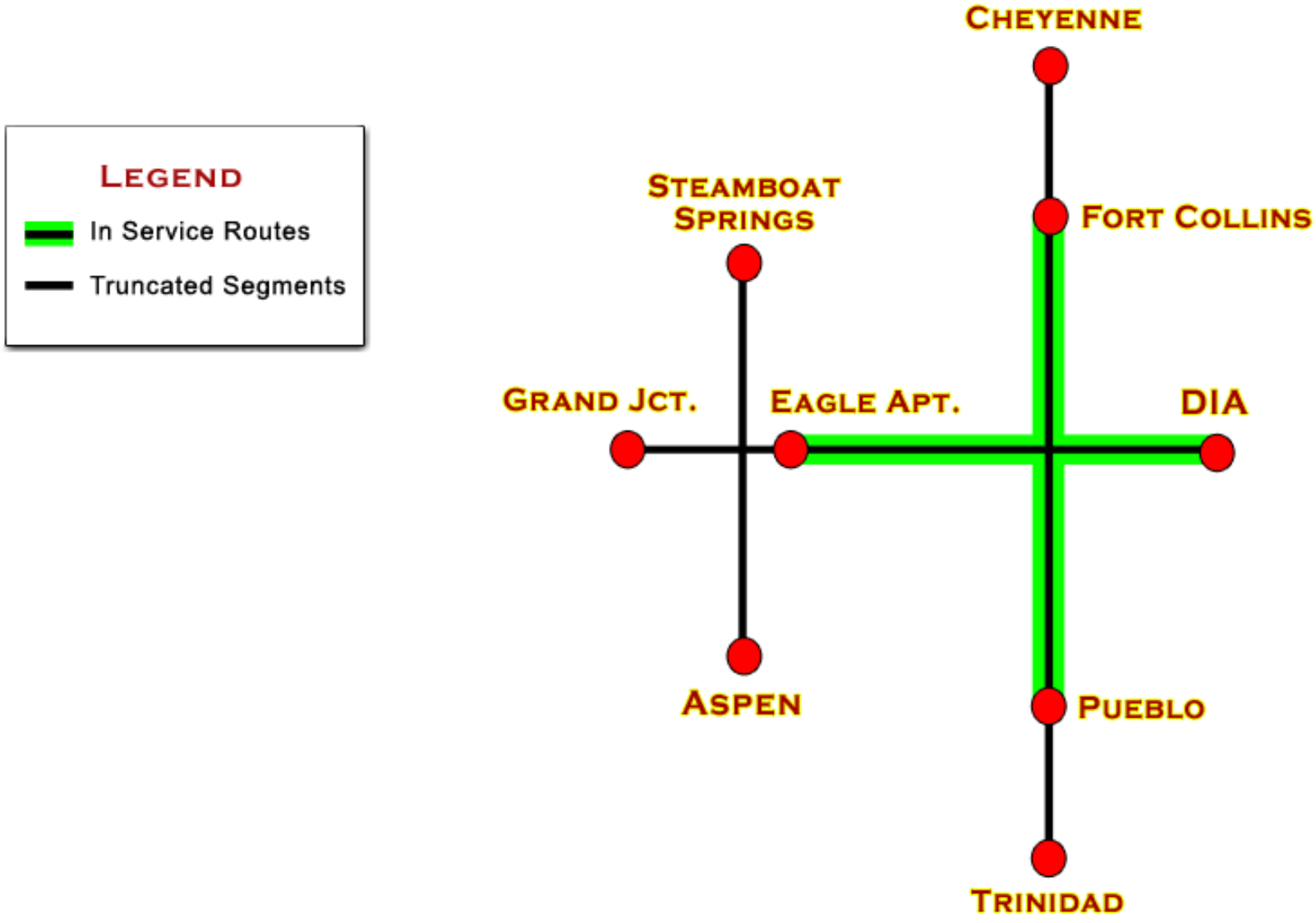
Preliminary Economic Evaluation of Full Network Alternatives – 2035 – Central Case (millions of dollars)

	79-mph ER Full	110-mph ER Full	125-mph 7%/GF Full	150-mph 4%/ER Full	220-mph 7%/GF Full	300-mph 7%/GF Full
BENEFITS	1a/b	2a/b	3a	4	5b	6a
Revenue	36.46	117.00	600.66	586.33	795.79	893.10
Consumer Surplus	7.74	117.45	513.80	543.87	720.81	682.55
Resource Savings	3.39	72.66	312.18	312.18	390.22	444.05
Total Benefits	47.59	307.1124	1426.639	1442.379	1906.824	2019.698
COSTS						
Operating Costs	68.94	132.36	373.10	416.09	484.43	448.38
Capital Costs	230.74	237.22	4241.84	1799.59	2255.20	4827.45
Total Costs	299.68	369.58	4614.94	2215.68	2739.63	5275.83
Cost Benefit Ratio	**0.16**	**0.83**	**0.31**	**0.65**	**0.70**	**0.38**

All Full Network options fail the first-cut Cost Benefit test, because of low density line segments south of Pueblo, north of Fort Collins and west of Eagle.

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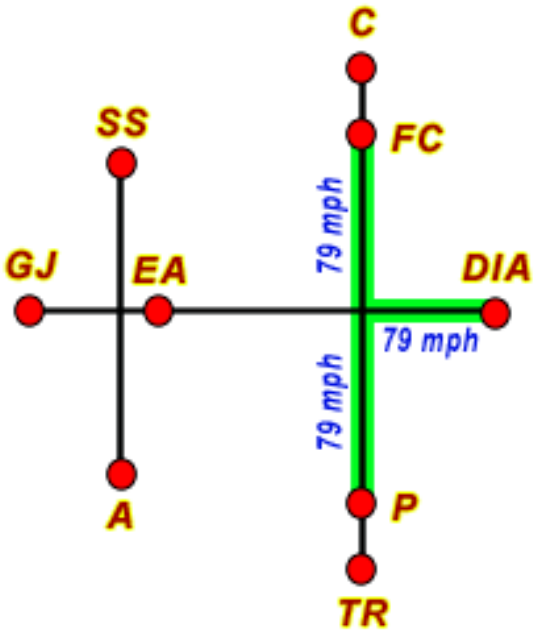
Development of Truncation Options for I-70 and I-25 Corridors



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79-mph/110-mph Existing Rail Truncated Phase 1 Alternatives

Option 1: 79-mph

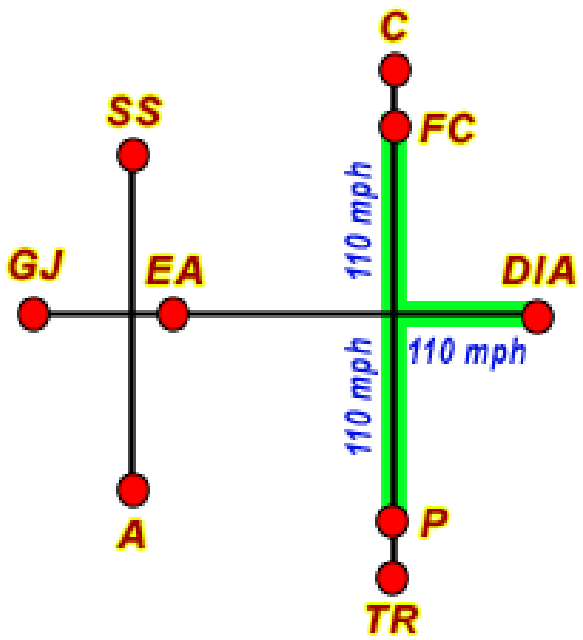


OPTION 1: Capital Costs

I-25:	2.7	Billion
I-70:	/	Billion
Vehicle:	0.1	Billion
TOTAL:	**2.9**	**Billion**

Only Serves I-25

Option 2: 110-mph



OPTION 2: Capital Costs

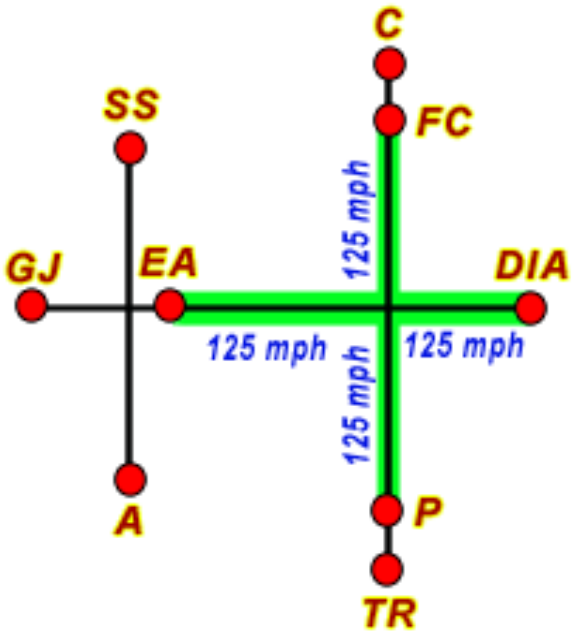
I-25:	2.7	Billion
I-70:	/	Billion
Vehicle:	0.2	Billion
TOTAL:	**2.9**	**Billion**

Only Serves I-25

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125-mph/150-mph Truncated Phase 1 Alternatives

Option 3: 125-mph (7% GF)

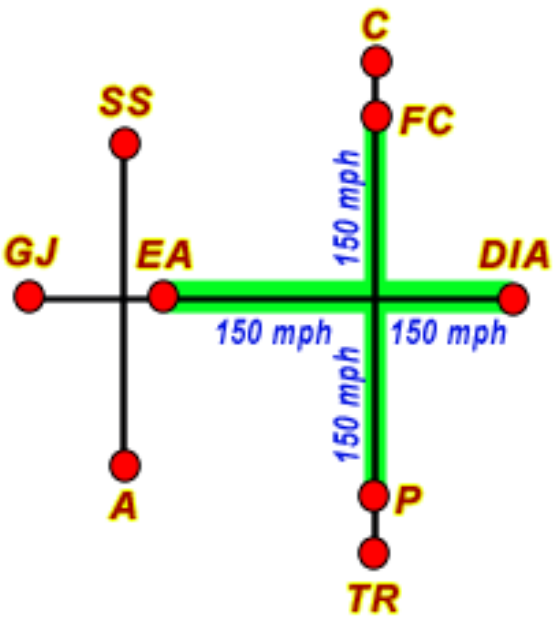


OPTION 3: Capital Costs

I-25:	16.9	Billion
I-70:	13.7	Billion
Vehicle:	1.0	Billion
TOTAL:	**31.6**	**Billion**

No Service West of Eagle County Airport

Option 4: 150-mph (4% ER)



OPTION 4: Capital Costs

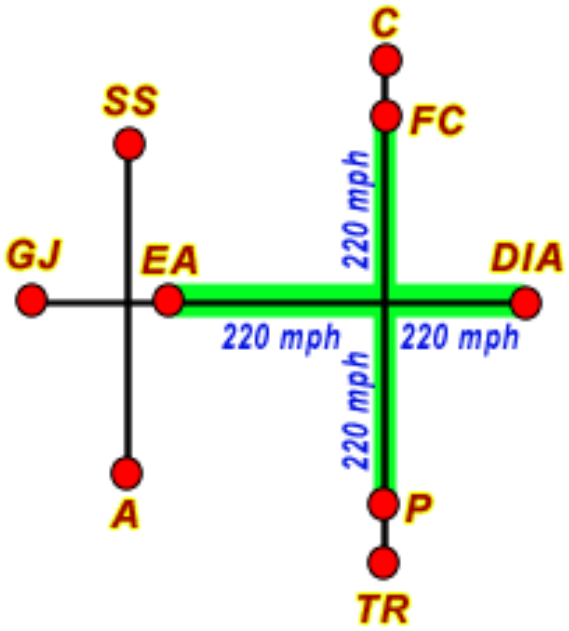
I-25:	2.9	Billion
I-70:	15.6	Billion
Vehicle:	0.4	Billion
TOTAL:	**18.9**	**Billion**

No Service West of Eagle County Airport

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220-mph/300-mph Truncated Phase 1 Alternatives

Option 5: 220-mph (7% GF)

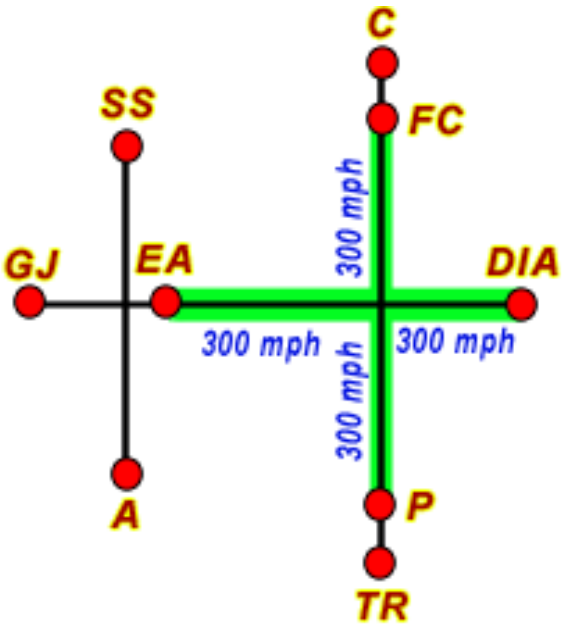


OPTION 5: Capital Costs

I-25:	6.0	Billion
I-70:	13.3	Billion
Vehicle:	0.6	Billion
TOTAL:	**19.9**	**Billion**

No Service West of Eagle County Airport

Option 6: 300-mph (7% GF)



OPTION 6: Capital Costs

I-25:	19.2	Billion
I-70:	15.6	Billion
Vehicle:	1.8	Billion
TOTAL:	**36.6**	**Billion**

No Service West of Eagle County Airport

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Truncated Routes: Capital Costs Summary (2008$ Billions)

Option	Description	I-25	I-70	Vehicle	Total
Option 1	79-mph ER Truncated	$2.7	$0.0	$0.1	$2.8
Option 2	110-mph ER Truncated	$2.7	$0.0	$0.2	$2.9
Option 3	125-mph 7% + GF Truncated	$16.9	$13.7	$1.0	$31.6
Option 4	150-mph 4% + ER Truncated	$2.9	$15.6	$0.4	$18.9
Option 5	220-mph 7% + GF Truncated	$6.0	$13.3	$0.6	$19.9
Option 6	300-mph 7% + GF Truncated	$19.2	$15.6	$1.8	$36.6

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Preliminary Economic Evaluation of Alternatives – 2035 – Central Case Truncated (millions of dollars)

	79-mph ER Trunc	110-mph ER Trunc	125-mph 7%/GF Trunc	150-mph 4%/ER Trunc	220-mph 7%/GF Trunc	300-mph 7%/GF Trunc
BENEFITS	1	2	3	4	5	6
Revenue	33.29	107.64	600.29	544.25	754.58	874.03
Consumer Surplus	7.07	112.23	792.95	700.02	960.66	955.30
Resource Savings	3.10	64.59	296.57	296.57	370.71	421.85
Total Benefits	43.45	284.46	1689.81	1540.84	2085.95	2251.18
COSTS						
Operating Costs	51.74	94.68	319.60	344.25	409.60	357.90
Capital Costs	173.75	178.64	1946.56	1164.24	1225.84	2254.56
Total Costs	225.49	273.32	2266.16	1508.49	1635.44	2612.46
Cost Benefit Ratio	**0.19**	**1.04**	**0.75**	**1.02**	**1.28**	**0.86**

All "Two Corridor" Maglev Options Fail the Cost Benefit test even after truncation, because of the high cost of Greenfield construction on the I-25 corridor. However, 300-mph Maglev does better than 125-mph Maglev. All rail options survive.

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Development of Mix and Match Strategies –

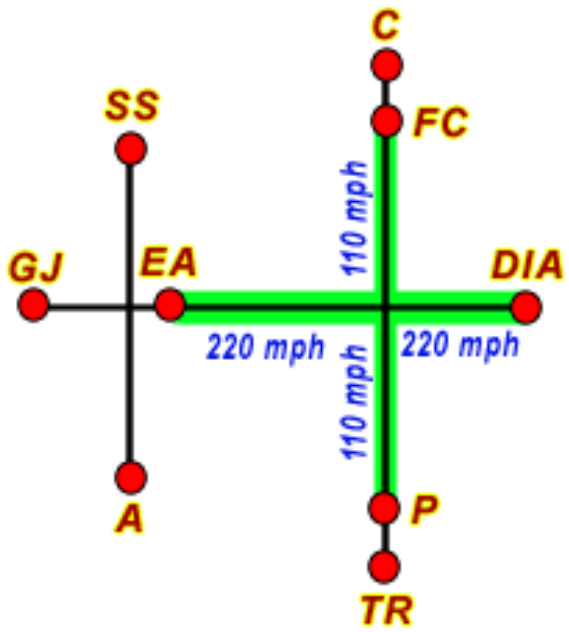
Combinations of Technologies on Different Corridors

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Mix and Match Phase 1 Alternatives

Option 7:

220-mph (7% GF) w/ 110-mph ER on I-25



OPTION 7: Capital Costs

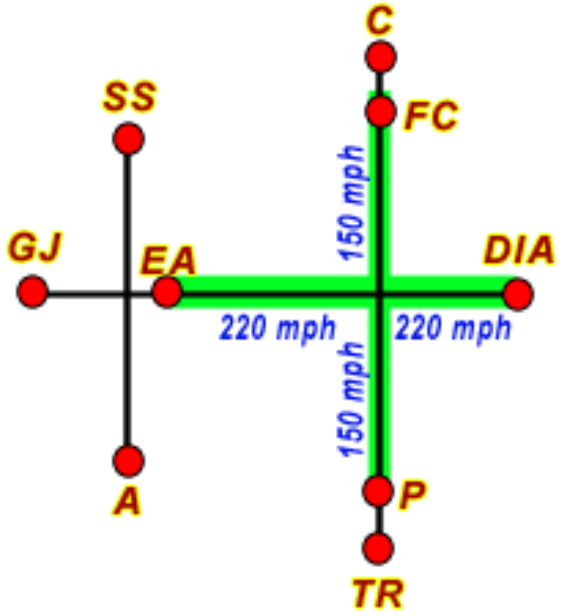
I-25:	2.5	Billion
I-70:	13.3	Billion
Vehicle:	0.5	Billion
TOTAL:	**16.3**	**Billion**

Transfer at Denver

No Service West of Eagle County Airport

Option 8:

220-mph (7% GF) w/ 150-mph ER on I-25



OPTION 8: Capital Costs

I-25:	2.9	Billion
I-70:	13.3	Billion
Vehicle:	0.6	Billion
TOTAL:	**16.8**	**Billion**

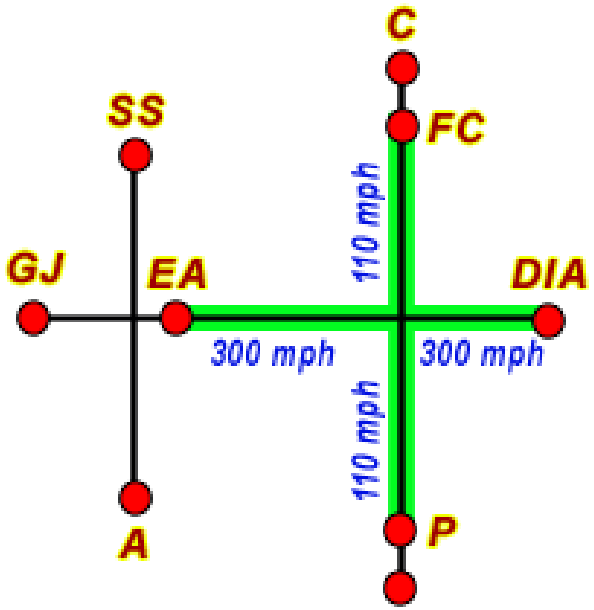
No Service West of Eagle County Airport

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Mix and Match Phase 1 Alternatives

Option 9:

300-mph (7% GF) w/ 110-mph ER on I-25



OPTION 9: Capital Costs

I-25:	2.6	Billion
I-70:	15.6	Billion
Vehicle:	1.3	Billion
TOTAL:	**19.5**	**Billion**

Transfer at Denver

No Service West of Eagle County Airport

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Mix and Match: Capital Costs Summary (2008$ Billions)

Option	Description	I-25	I-70	Vehicle	Total
Option 7	220 on I-70 7%, w 110 on I-25 ER	$2.5	$13.3	$0.5	$16.3
Option 8	220 on I-70 7%, w 150 on I-25 ER	$2.9	$13.3	$0.6	$16.8
Option 9	300 on I-70 7%, w 110 on I-25 ER	$2.6	$15.6	$1.3	$19.5

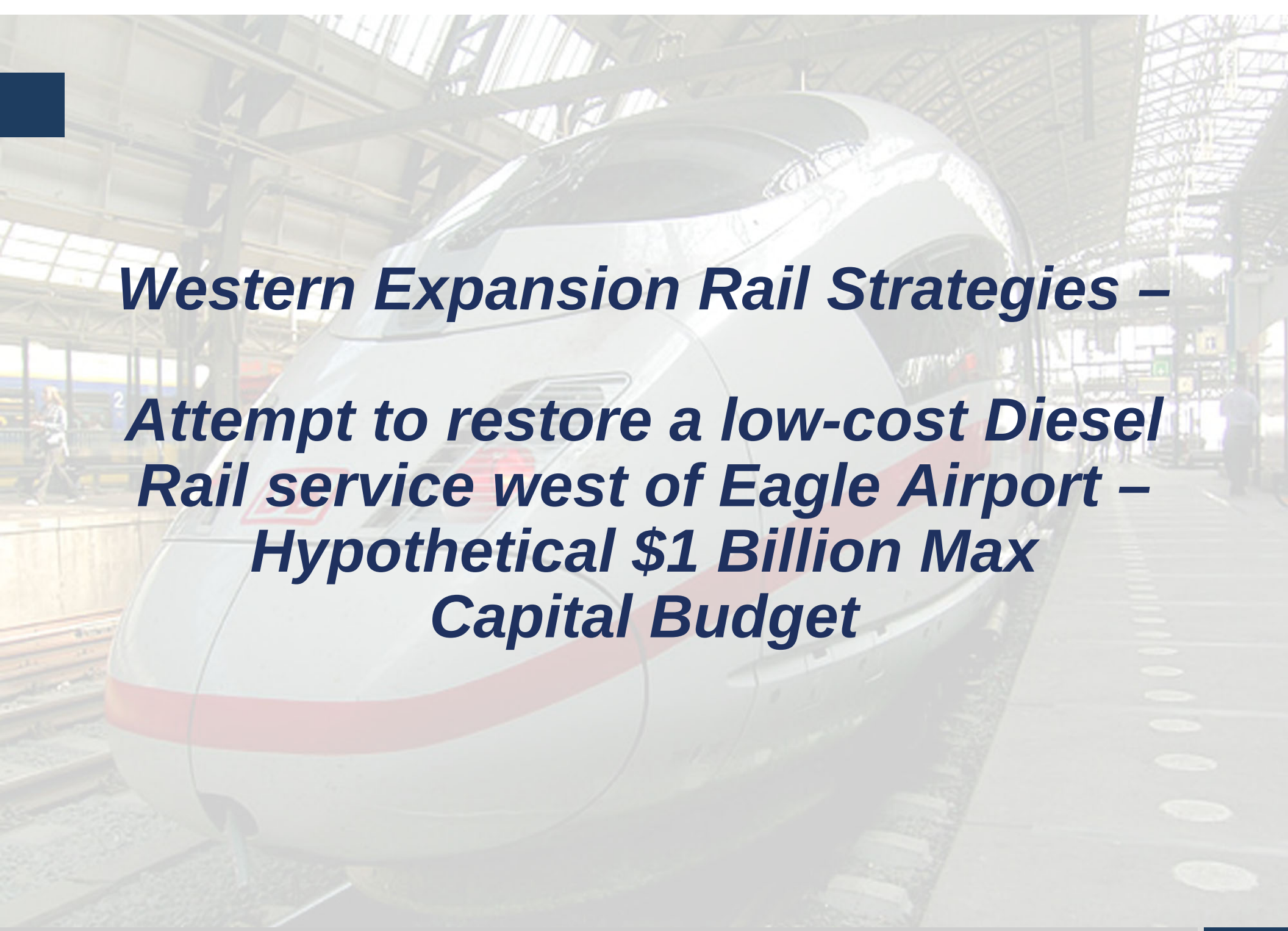
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Preliminary Economic Evaluation of Alternatives – 2035 – Central Case Mix and Match (millions of dollars)

	Carry Fwd	New Mix and Match Alternatives		
	220-mph 7% / GF Trunc	110-mph ER T on I-25 w/ 220-mph 7% T on I-70	150-mph ER T on I-25 w/ 220-mph 7% T on I-70	110-mph ER T on I-25 w/ 300-mph 7% T on I-70
BENEFITS	**5**	**7**	**8**	**9**
Revenue	754.58	492.56	633.74	511.83
Consumer Surplus	960.66	646.2	717.76	609.29
Resource Savings	370.71	241.50	340.98	407.00
Total Benefits	2085.95	1380.26	1692.48	1528.12
COSTS				
Operating Costs	409.60	341.21	377.16	270.13
Capital Costs	1225.84	1010.24	1034.88	1201.20
Total Costs	1635.44	1351.45	1412.04	1471.33
Cost Benefit Ratio	**1.28**	**1.02**	**1.20**	**1.04**

***All Mix-and-Match Options Survive* the Cost Benefit test, including one option for 300-mph Maglev on I-70. However, the All-Electric Rail options 5 and 8 perform best.**

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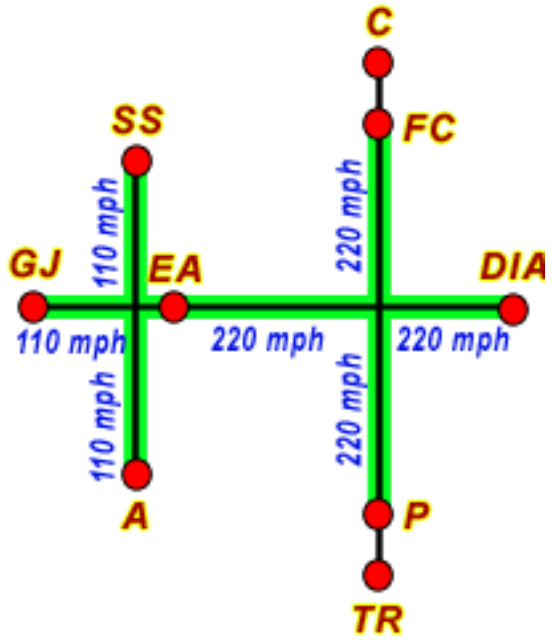
Western Expansion Rail Strategies –

Attempt to restore a low-cost Diesel Rail service west of Eagle Airport – Hypothetical $1 Billion Max Capital Budget

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Western Expansion
Phase 2 Alternatives: Option 1

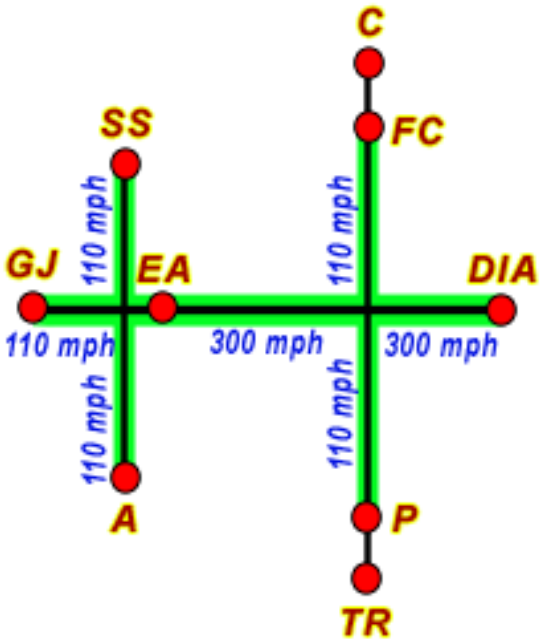
Option 5W



OPTION 5W: Capital Costs

I-25:	6.0	Billion
I-70:	13.3	Billion
Western Routes:	1.0	Billion
Vehicle:	0.8	Billion
TOTAL:	**21.1**	**Billion**

Option 9W



OPTION 9W: Capital Costs

I-25:	2.6	Billion
I-70:	15.6	Billion
Western Routes:	1.0	Billion
Vehicle:	1.5	Billion
TOTAL:	**20.7**	**Billion**

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Western Expansion: Capital Costs Summary (2008$ Billions)

Option	Description	I-25	I-70	Western	Vehicle	Total
Option 5W	220 GF 7% T w/110 ER w of Eagle	$6.0	$13.3	$1.0	$0.8	$21.1
Option 9W	300 GF 7% on I-70 w/110 ER on I-25 and w of Eagle	$2.6	$15.6	$1.0	$1.5	$20.7

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Preliminary Economic Evaluation of Alternatives – 2035 – Central Case Western Expansion Alternatives Phase 3 (millions of dollars)

***Both Western Expansion Options Survive** the Cost Benefit test.*

***220-mph Electric Rail** does better because it can provide a seamless one-seat ride in the I-25 corridor. Maglev remains viable for the I-70 core because of its strong ridership appeal.*

	220-mph 7% / GF Trunc w 110 W of Eagle	300-mph 7% on I-70 w/110 on I-25 and W of Eagle
BENEFITS	5W	9W
Revenue	781.27	569.18
Consumer Surplus	980.08	637.37
Resource Savings	380.67	430.78
Total Benefits	2142.02	1637.33
COSTS		
Operating Costs	469.60	320.13
Capital Costs	1299.76	1275.12
Total Costs	1769.36	1595.25
Cost Benefit Ratio	**1.21**	**1.03**

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Recommendations and Conclusions

- **Recommend to Remove**
 - 79-mph Rail: Operating Subsidy, Poor Cost/Benefit Ratio
 - 125-mph Maglev: Poor Cost/Benefit Ratio
 - Truncated I-25 Segments, Poor Cost/Benefit Ratio
- **Recommended to Retain for Detailed Analysis:**
 - Best Option: 220-mph (5W) Electric on both I-25 and I-70 with potentially some 110-mph Western Extensions.
 - **Meets all FRA Economic and Financial criteria.**
 - **Provides a single-seat ride between I-70 and I-25.**
 - **Estimated Cost: $21.1 Billion**
- **I-25/I-70 Synergy**
 - The results confirm the findings of the I-70 PEIS that a standalone I-70 rail or maglev alternative is not viable.
 - It is the synergy of the I-25 and I-70 together that produces a viable solution for both corridors.

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Development of System: Criteria for Implementation Plan

- **Analysis to determine how to develop the system. Aim to achieve the following goals:**
 - Minimize operating cost losses
 - Maximize geographic coverage
 - Maximize economic and environmental benefits
 - Develop system in line with reasonable financing capability.

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Discussion of Results

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Thank You.

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